

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 66

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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No. 6

The Roentgen Findings in Primary Hepatoma in Infants and Children

An Analysis of Eleven Cases¹

ALEXANDER R. MARGULIS, M.D., CHARLES M. NICE, Jr., M.D., and LEO G. RIGLER, M.D.

PRIMARY HEPATOMA is of relatively rare occurrence in infants but, in spite of its low incidence, it is one of the commonest neoplasms of the liver seen in infancy and early childhood. Although numerous articles have been written about its pathology, clinical aspects, and therapy, no study could be found in which there was an attempt to establish roentgen criteria for the diagnosis. This paper will deal with roentgen findings in 11 cases of primary hepatoma in infants and young children.

It is significant that the cases to be presented, despite their relative rarity, were hitherto unreported. This may serve to indicate that such tumors are not really as rare as the isolated case reports (with reviews of all the previously recorded cases) would suggest. Steiner (18) found only 77 cases (including 2 of his own) in children under sixteen years in which he considered the diagnosis justified. Bigelow and Wright, in 1953, assembled 95 proved cases and added 1 of their own (2). Still another case was added by Tomsykoski and Stevens (21). The total number of cases thus far reported is therefore somewhere in the neighborhood of one hundred. Our belief, however, is that these neoplasms are much more common than that figure

indicates, since almost every hospital in the Minneapolis and Saint Paul area to which the authors had access had a record of at least one case, and the University of Minnesota Hospitals had several. The explanation may lie in the reluctance of many physicians to report isolated cases.

PATHOLOGY

Primary carcinomas of the liver in children and infants fall mainly into two categories: ordinary hepatomas and embryonal carcinomas. Willis (24), however, points out that the distinction between truly embryonic liver-cell tumors and ordinary hepatomas arising in childhood may be neither histologically possible nor theoretically valid, since they may differ only in their time of origin. It is further stated by Willis that no sharp distinction can be drawn between embryonal hepatomas of pure epithelial structure and those showing a preponderance of mesenchymal elements, all combinations being encountered. Abnormal epithelial growth, either of liver or bile-duct type, is always a part of the tumor.

The embryonal tumors of the liver are similar to embryonal renal tumors and, like the latter, may contain all kinds of heterotopic tissues—cartilage, osteoid,

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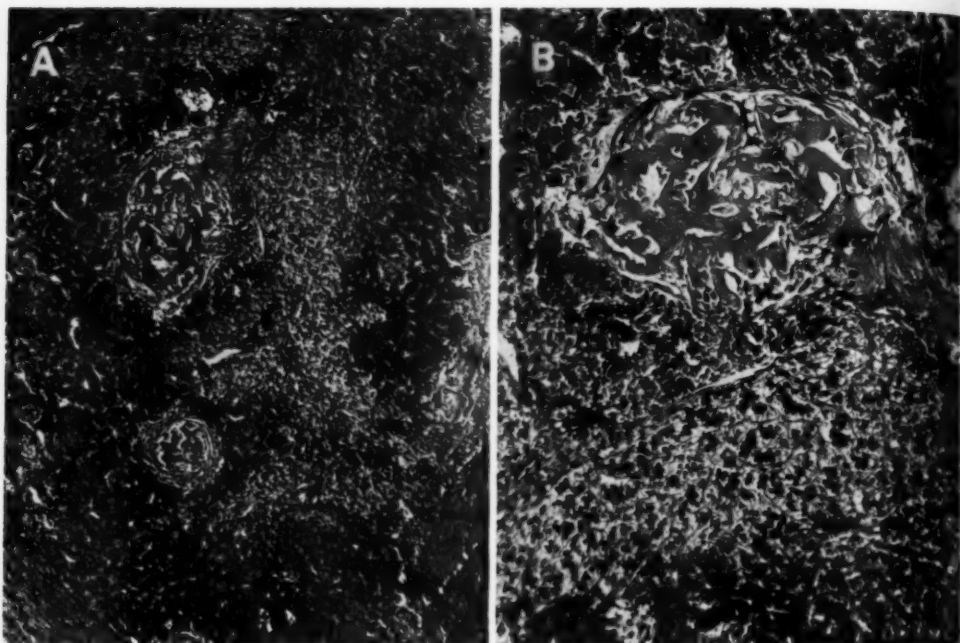


Fig. 1. Microscopic sections illustrating elements encountered in an embryonal hepatoma. Beside the epithelial elements resembling liver cells, there are areas containing bone and osteoid. A. Field in tumor under low-power magnification. B. Same field under high-power magnification.

bone, striated muscle, etc. These elements may be present in only part of the tumor, thus making the distinction between ordinary hepatoma and hepatoblastoma even more difficult and less valid. Somewhat less than half of the reported tumors contained mixed elements. Milman and Grayzel, in 1951, compiled 27 mixed embryonal liver carcinomas (9), of which 9 were in adults and 18 in children below eight years of age. Of the latter number, 9 were in infants of less than one year.

The microscopic slides for our series, except for a single case, were reviewed by Dr. Robert Hebbel of the Department of Pathology of the University of Minnesota. In the case in which it was impossible to get the slides for review, there was operative proof of the tumor and the slides had been interpreted by a competent pathologist. Three of the 11 neoplasms contained mesenchymal elements in addition to tumor cells of epithelial origin. Figure 1 demonstrates the findings in a typical

case of mixed embryonal tumor. Epithelial elements resembling liver cells are seen alongside bone and osteoid. Eight cases did not show mixed elements. This does not indicate, however, that the two types of tumor are clearly separate.

CLINICAL FINDINGS

Seven of the 11 patients were girls. The youngest of the series was four days, the oldest nine years of age. Seven were less than fourteen months of age. All the mixed embryonal hepatomas were in this younger group.

The duration of symptoms ranged from four days to five months. Four patients were completely asymptomatic, with an abdominal mass discovered on routine physical examination. The symptoms in the others consisted most frequently of tiredness, weakness, and some form of abdominal pain. One patient was asymptomatic until he fell out of bed and was admitted to the hospital with signs of

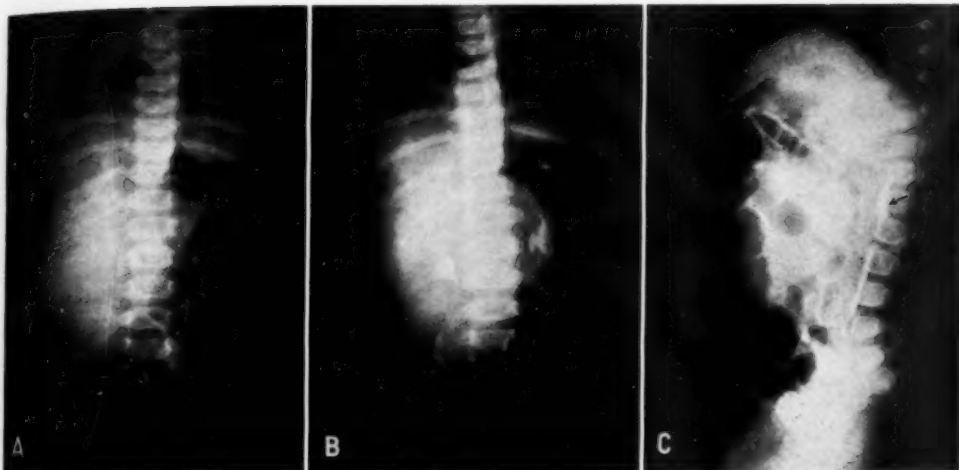


Fig. 2. Primary carcinoma of the right lobe of the liver in a girl six months old.

A. The arrow points to the calcification within the tumor. The tumor is inseparable from the liver, while the kidney shadow can be seen separate from it.

B. Excretory pyelogram showing extrinsic compression of the right kidney.

C. A lateral excretory pyelogram showing the right kidney pelvis and upper ureter displaced posteriorly (arrow). The mass with its calcification is well anterior to the kidney. There is small bowel against the spine in normal position, indicating that the tumor is not retroperitoneal.

acute intra-abdominal hemorrhage. Only the four-day-old infant had pronounced jaundice, which was proved conclusively not to be due to erythroblastosis fetalis. Two had mild jaundice; 8 were free from it. With the exception of the four-day-old infant, all of the group were anemic. The anemia was mild (between 12 and 13 gm. hemoglobin) in the older children and moderate to severe (below 10 gm.) in the infants. One three-year-old boy had a hemoglobin of 10.9 gm.

On physical examination, all the patients showed an abdominal mass, the relationship to the liver was more difficult to establish in the 3 cases where the left lobe was mainly involved. Two patients were considered inoperable clinically and died shortly after admission. In 4, the involved lobe of the liver was resected: 2 of these were well and clinically free of metastases when last seen, six months postoperatively; 1 died shortly after the operation, due to bleeding from a tear in the hepatic vein, and 1 died with multiple metastases nine months after resection. In this last case, pulmonary metastases were present three months after

operation and the patient received x-ray therapy. In 1 patient, only the right lobe of the liver was found definitely to be involved. The surgeon felt, however, that because of the presence of ascites the neoplasm was unresectable and advised irradiation. In the remainder of the patients, tumor was found, on exploratory laparotomy, throughout the entire liver, and only palliative irradiation was given. One patient received nitrogen mustard through a polyethylene tube inserted into the hepatic artery at the time of operation.

ROENTGEN FINDINGS

In several clinical accounts of isolated cases some roentgen findings were reported but no attempt was made at their correlation (2, 3, 7, 8, 14, 16, 19, 20). In only two papers (11, 12), to our knowledge, were any reproductions of the roentgenograms published. The diagnosis of Wilms' tumor was not infrequently made, although this could easily have been excluded if the necessary roentgen studies had been made.

On the basis of an analysis of our 11

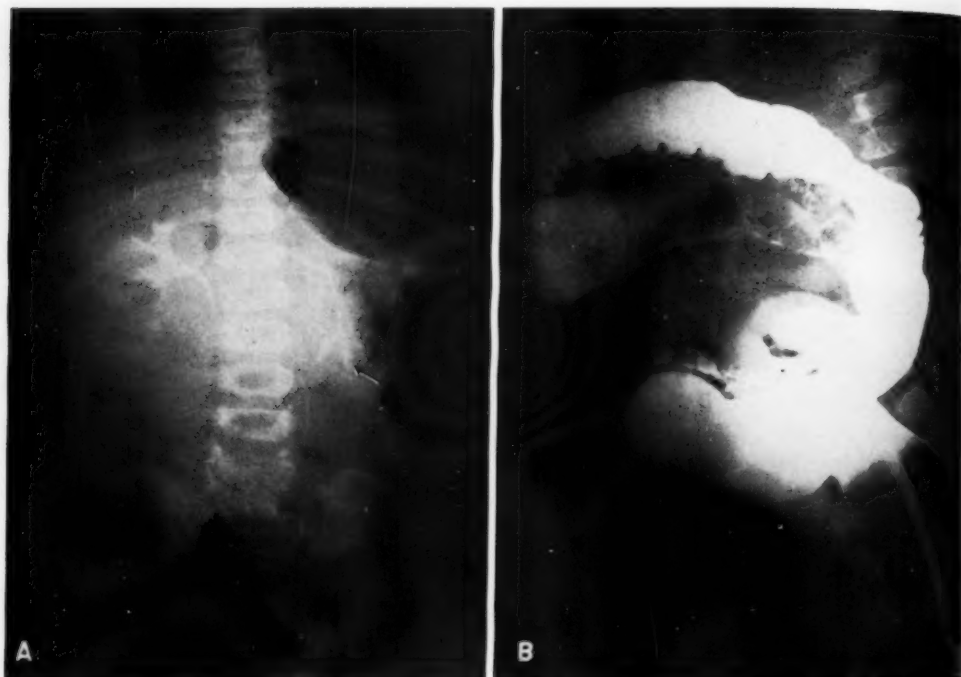


Fig. 3. Primary carcinoma of left lobe of the liver in a girl seven and a half months old.
 A. Excretory pyelogram. The arrow points to the left kidney, which was compressed posteriorly and downward. The stomach is greatly displaced to the left.
 B. Lateral view of the colon. The ascending and descending colon are in normal position, since they are retroperitoneal. The transverse colon, which has a long mesentery and is intraperitoneal, is wrapped around the mass.

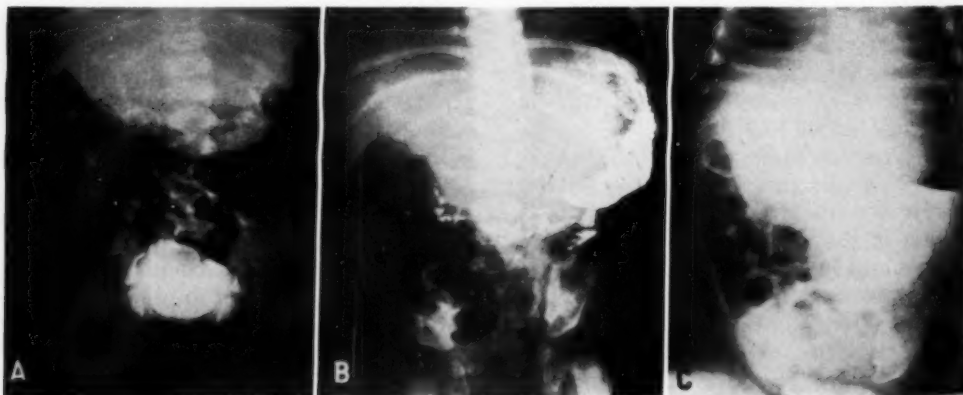


Fig. 4. Hepatoblastoma of left lobe of liver in a three-month-old girl.
 A. Excretory pyelogram. Slight downward displacement of the left kidney by a centrally located mass.
 B. Upper gastrointestinal film. The stomach is displaced greatly to the left by the tumor. The second portion of the duodenum, which is retroperitoneal, is not displaced and remains in position as an anchoring point. The duodenojejunal juncture is displaced downward. (On the lateral film, which is not reproduced here, it was not displaced anteriorly.)
 C. The undulating border of the mass is well outlined against the shadow of the air-filled stomach.

TABLE I: ROENTGEN FINDINGS CORRELATED WITH THE LOCATION OF THE TUMOR IN THE LIVER

| Location of Tumor in the Liver | Appearance of Mass | Displacement of Colon | Displacement of Stomach and Duodenum | Displacement of Duodenojejunal Junction | Displacement of Right Kidney | Displacement of Left Kidney |
|--------------------------------|---|--|---|--|--|--|
| Right lobe: 5 cases | Large mass in right upper abdomen inseparable from the liver. Lower border is wavy. Mass frequently extends across the mid-line. It may be calcified | The hepatic flexure is depressed. The transverse colon is usually displaced anteriorly and downward, especially on the right side. The peritoneal attachments remain posterior | The stomach is usually displaced somewhat to the left. Anterior displacement is more common than posterior in this group. The second portion of the duodenum is not displaced | None | May be displaced downward and medially. May be displaced posteriorly | None |
| Left lobe: 3 cases | Large centrally located upper abdominal mass extending to the left side, adjacent to the liver and inseparable from it. Lower margin is wavy. It may be calcified | The splenic flexure may be depressed. The transverse colon is displaced anteriorly but may be pushed down or up. The peritoneal attachments remain posterior | Very marked displacement of the stomach to the left. It may also be displaced anteriorly or posteriorly. The second portion of the duodenum serves as an anchoring point | Displaced downward but not anteriorly in one case only | None | May be depressed and pushed back or not displaced at all |
| Entire liver: 3 cases | The findings are a combination of those encountered in tumors involving the right and left lobes of the liver. The degree of preponderance is variable | | | | | |

cases, we have reached the conclusion that a presumptive diagnosis of hepatoma can be made roentgenologically in an anemic child with a growing mass in the upper abdomen. Roentgen studies will make possible localization of the mass intraperitoneally by demonstrating displacement of the anatomic landmarks. The kidney on the involved side is usually seen to be separate from the tumor; furthermore it may be depressed and pushed back (Fig. 2, B and C). The duodenojejunal junction, which is intimately fixed to the retroperitoneal structures by the ligament of Treitz, is never pushed forward, a sign that is easily verified by a lateral film of the gastrointestinal tract. The portions of the ascending and descending colon that are retroperitoneal can be seen posteriorly in normal position, while the transverse colon, with its long mesentery, is displaced anteriorly, frequently

being wrapped around the mass (Fig. 3B). The second portion of the duodenum is also seen in its normal retroperitoneal position. The landmarks for determination of intraperitoneal or extraperitoneal masses in children are described and discussed in more detail elsewhere (25). The mass of a primary carcinoma of the liver is inseparable from the liver and usually presents an undulating lower border (Figs. 4C and 5A). Calcification within the mass was clearly present in 3 of our 11 cases (Figs. 2A and 5A).

An analysis of the roentgenograms was undertaken, and the changes were correlated with the observations at surgery and at autopsy. Three types of roentgen findings were recognized, depending on whether the right or left lobe of the liver, or both, harbored the neoplasm. The most frequent findings are shown in Table I. In 5 cases the tumor was in the right lobe of

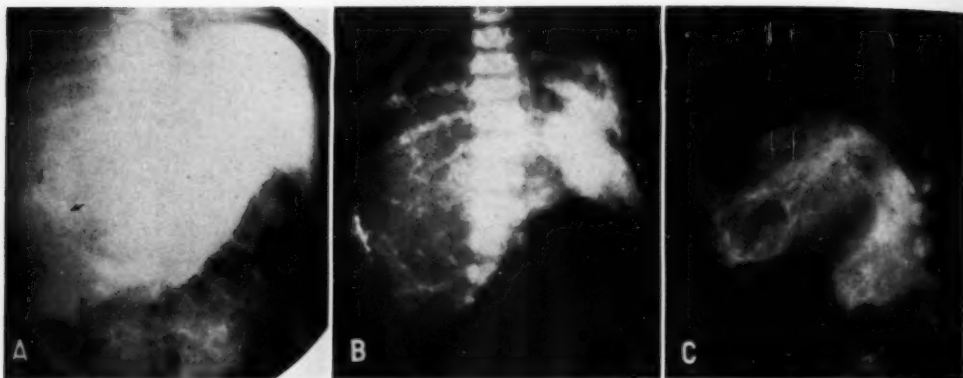


Fig. 5. Hepatoblastoma involving the entire liver in a girl fourteen months old.

- A. Large mass in right and central upper abdomen with undulating lower border. Arrows point to calcified area.
 B. Following injection of Thorotrast, normal liver tissue has picked up the contrast material, while the tumor tissue is not opacified.
 C. Lateral view after Thorotrast injection demonstrates very well the character of involvement of the liver.

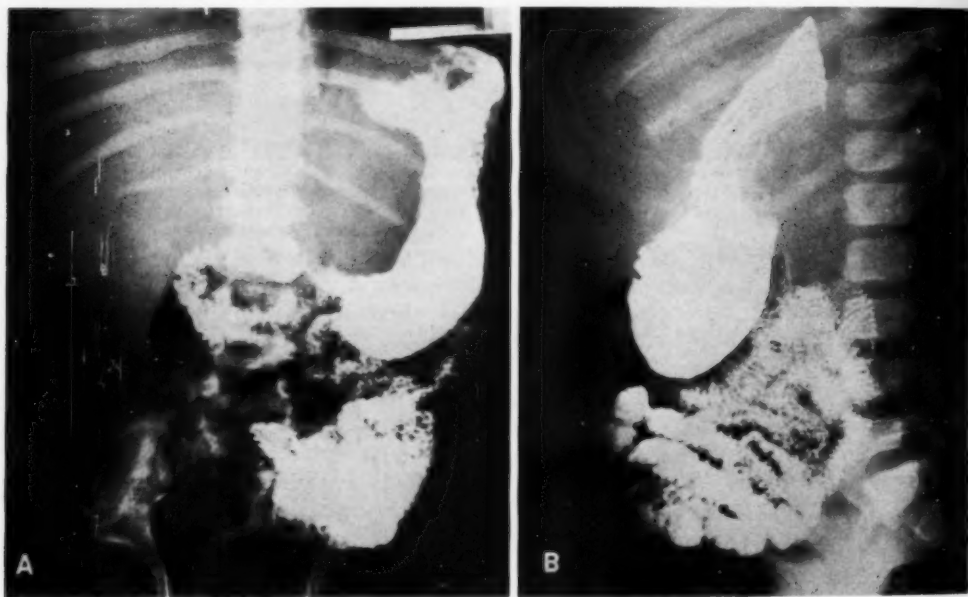


Fig. 6. Primary carcinoma of the liver in a three-year-old boy.

- A. The stomach is displaced to the left by a mass in the central and left upper abdomen. The second portion of the duodenum remains in normal position.
 B. Lateral upper gastrointestinal view. A large, rather sharply outlined mass is compressing the stomach from behind.

the liver, in 3 it was in the left, and in 3 the entire liver was involved, so that it was impossible to determine the site of origin. The data in the table are easily understood when it is considered that a carcinoma of the left lobe of the

liver is, in effect, a centrally located intra-peritoneal tumor, while a carcinoma of the right lobe is a right upper abdominal tumor. Masses in these two locations will displace different structures. Figure 2 shows some findings in carcinoma of the

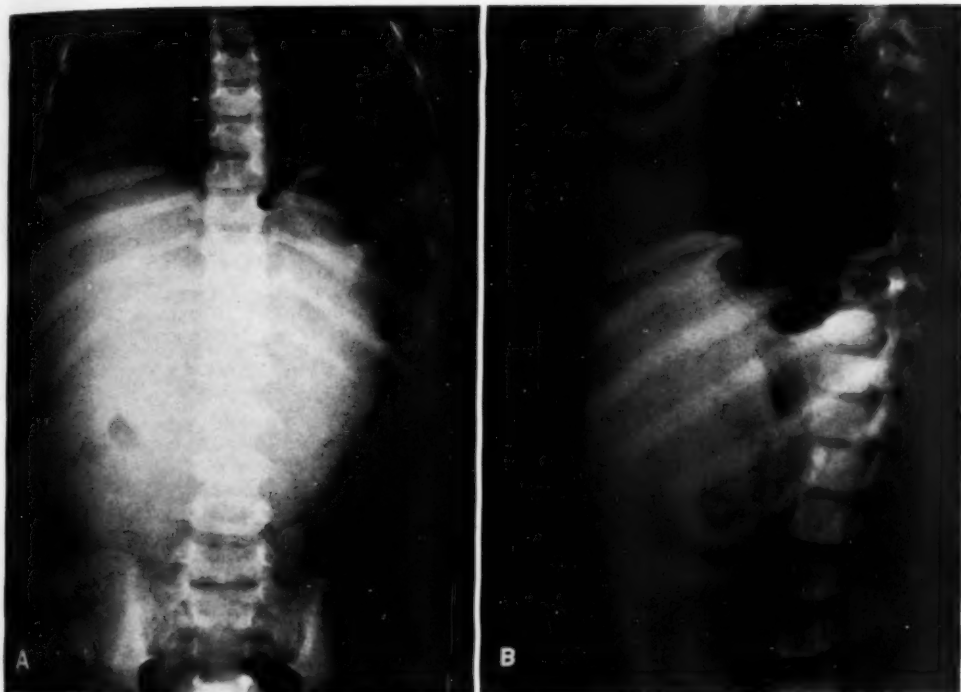


Fig. 7. Cyst of the liver in a two-year-old girl.

- A. Mass displacing the stomach markedly to the left is sharply outlined, with a rounded regular border.
 B. The mass is situated anteriorly. The stomach is displaced posteriorly, but the duodenojejunal junction is in normal position, indicating the intraperitoneal position of the mass.

right lobe of the liver; Figure 4 is illustrative of a tumor of the left lobe. When the entire liver is involved, the findings are, as would be expected, a combination of those caused by right and left lobe enlargement. The tumor then usually occupies the entire abdomen with the exception of the left lower quadrant; the displacement of surrounding structures, however, typically remains that caused by an intraperitoneal mass.

In the case presented in Figure 5 a primary embryonal carcinoma of the liver involved the entire organ. Thorotrast was injected (this was done before the dangers of Thorotrast were realized) and was picked up by that portion of the liver tissue in which the reticuloendothelial apparatus was intact. The tumor did not pick up Thorotrast and is shown as multiple radiolucent nodules and conglomerate masses (Fig. 5, B and C).

It is both unusual and difficult to discover a primary hepatoma before it becomes massive and involves most of one lobe of the liver. In the case presented in Figure 6 detection was made somewhat sooner because of the massive intraperitoneal hemorrhage after the patient fell out of bed. The large discrete mass in the left lobe, displacing and impinging on the stomach, proved to be a hepatoma. In the opinion of Bigelow and Wright, even multiple nodules of a primary neoplasm scattered through the liver represent widespread dissemination from a single focus.

The differential diagnosis of primary carcinomas of the liver includes sarcoma, hemangio-endotheliosarcoma, Hodgkin's disease, liver cysts, Wilms' tumor, and neuroblastoma with hepatic metastases. Differentiation from Wilms' tumor and neuroblastoma is not too difficult, since

it can be demonstrated that these tumors are retroperitoneal. Hodgkin's disease usually gives manifestations outside of the liver, in the form of retroperitoneal nodes and frequently mediastinal involvement. When cysts of the liver are large enough to produce symptoms, they usually present the appearance shown in Figure 7. This same picture was encountered in 3 consecutive cases. The mass is sharply demarcated and has a smooth, rounded margin in contrast to the wavy outline of a hepatoma. Sarcomas of the liver and hemangio-endotheliosarcomas are much rarer than hepatomas and unfortunately, up to now, there is no way of differentiating them from primary hepatomas by the roentgen method.

Cirrhosis of the liver, hepatitis, reticuloses, congestive hepatomegaly, abscess of the liver, and other causes of hepatomegaly can in most cases be differentiated from primary carcinoma of the liver in infancy and childhood if the roentgen findings of hepatomegaly are correlated with the history, physical findings, and pertinent laboratory data.

SUMMARY

An analysis of the clinical and roentgen findings in 11 cases of primary carcinoma of the liver in infants and young children was made. It was found that in the majority of cases the diagnosis could be made by simple roentgen studies such as upper and lower gastrointestinal tract examinations and urographic studies, with the aid of lateral views. The most frequent and helpful clinical signs were the presence of a growing upper abdominal mass and anemia.

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SUMARIO

**Los Hallazgos Roentgenológicos en el Hepatoma Primario en los Lactantes y Niños Mayores:
Análisis de Once Casos**

Este análisis de los hallazgos clínicos y radiológicos comprendió 11 casos de carcinoma primario del hígado en lactantes y niños pequeños. Observóse que, en la mayoría de los casos, podía hacerse el diagnóstico con sencillos estudios roentgenológicos, tales como exámenes de las

porciones superior e inferior del tubo gastrointestinal y estudios urográficos, con la ayuda de vistas laterales. Los signos clínicos más frecuentes y útiles fueron la presencia de una tumefacción creciente en la porción superior del abdomen y la anemia.



Clinical Pantomography of the Jaws¹

PEKKA SOILA, M.D., and YRJÖ V. PAATERO, O.D.

PANTOMOGRAPHY is a procedure which has been developed for the purpose of obtaining laminagrams of curved surfaces. This method employs a fixed source of radiation, while object and film are rotated on holders having equal radii and moving at equal speed through a peripheral frictional arrangement. The rather narrow roentgen beam reproduces on the film the layer of interest, which has the same linear velocity and direction of movement as the film itself. Structures outside this layer of equal linear velocity are blurred in the usual tomographic manner. The reproduced section, however, appears in essentially better detail than in conventional tomography.

For *concentric pantomography* the object is placed concentrically on the holder. This technic is best suited to structures of considerable length, e.g., the entire jaw, though it may entail some lack of detailed definition. In *eccentric pantomography*, the object is placed eccentrically on the holder. Thus, only a portion will be reproduced, with some gain in the quality of the roentgen image. The film may have any form, provided a constant speed is maintained in the region of the beam. Stereoscopic films are produced by horizontal or vertical tube shift. During stereoscopic viewing, the object assumes a curved appearance, and shadows caused by outside structures are less disturbing. In a single exposure, several films may be used, placed at different depths and, if viewed stereoscopically, will produce a plastic stereoscopic-like effect as well. A theoretical study of double-eccentric pantomography has recently been published.

In a routine concentric pantomogram of the jaws a line, caused by the compact, plate-like base of the skull, is not fully

eliminated. A more or less hazy upward-fading shadow is projected at the level of the maxillary teeth. This effect can be largely overcome by suitable tilting of the head. When the mouth is held wide open, the rays pass obliquely through the base of the skull, causing its shadow to be less dense, and the lower jaw is projected free, except for both articular processes. Other undesirable effects are caused by the bodies of the upper cervical vertebrae. These shadows, however, as a rule appear rather translucent and do not seriously interfere with reading of the films. On an eccentric pantomogram, as for example of half of the facial portion of the skull, the outside structures disappear completely; this, therefore, is a method of choice when a high degree of definition is required. If double-eccentric pantomography becomes possible, both halves of the jaws will be reproduced eccentrically with a single exposure.

The value of pantomography in examination of the jaws is based upon the free-projecting properties of the method. It is possible to demonstrate the entire jaws by rather simple means. The image layer possesses some depth, which depends upon the geometric factors employed, and can, to some extent, be varied. These qualities must be weighed against lack of definition which is, however, partly compensated by the special technics mentioned above.

The following problems, encountered in radiography of the jaws, are considered from the point of view of pantomography.

I. *Congenital Anomalies; Systemic Diseases:* Anomalies of the jaws proper are not very frequent. If present, they can be identified with accuracy and followed by pantomograms. In such cases pantomo-

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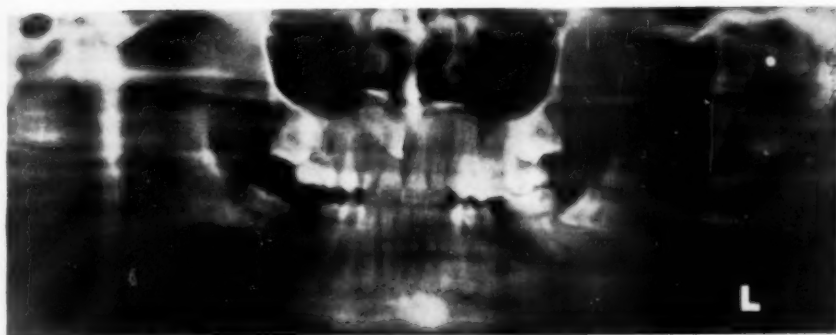


Fig. 1. Malposition of tooth.

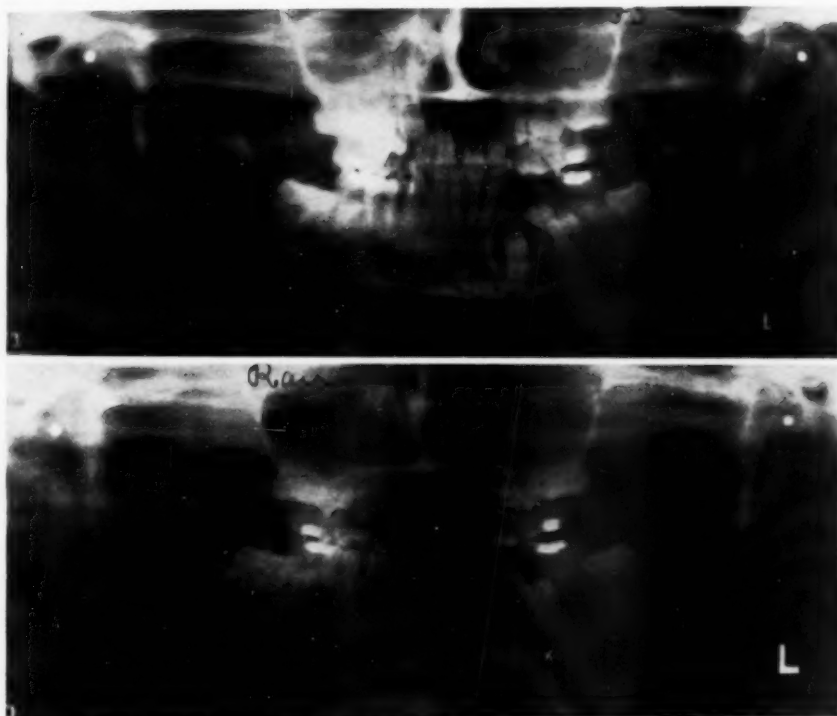


Fig. 2. Follicular cyst arising from a tooth. Pantomographs before and after operation.

graphic motion pictures would be helpful for functional studies. After intervention, the new status can be evaluated by a comparison with preceding films. Variations in development of the teeth are well demonstrated on pantomographs. Routine examinations in the presence of systemic diseases greatly benefit from the simplicity of the pantomographic process. Normal

osseous structure has a specific appearance, and against this background the existence and quality of pathologic changes may be determined.

II. *Traumatic Conditions; Surgery:* In traumatic cases, the blurring effect can largely be overlooked. Fractures, distinct defects of the bone, and dislocations are clearly outlined on the pantomogram.

Radiopaque foreign bodies in the region of the jaws are brought to the image layer by proper positioning of the patient, or several layers of the object are exposed simultaneously. A nearby structure, such as the inner layer of the mandible, is selected as a fixed landmark for deter-

appear especially clearly, and an exact diagnosis is often possible. Malignant changes, on the other hand, show no easily recognizable qualities. Particularly is this true in the case of minimal involvement at an early stage. Familiarity with the pantomographic appearance of the structures

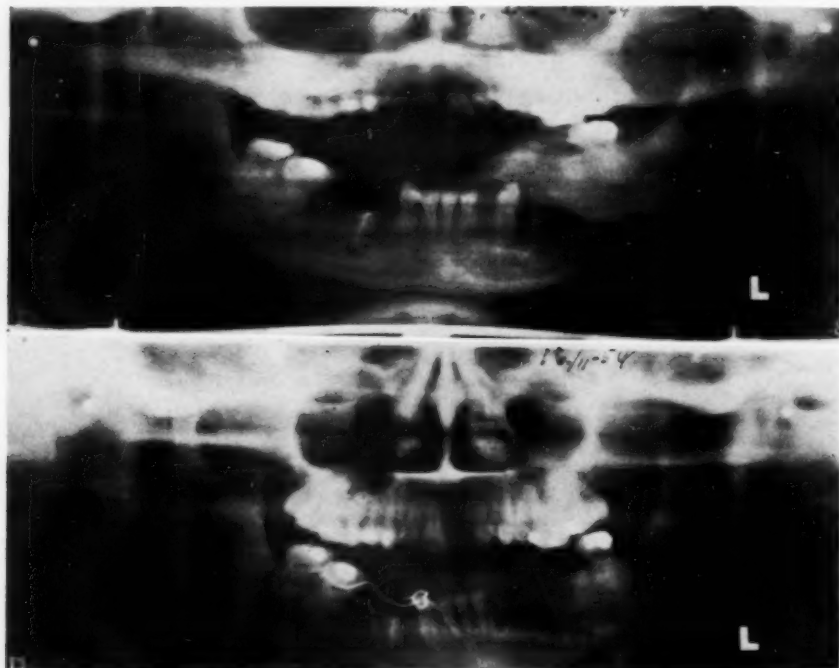


Fig. 3. Fracture of the mandible. Pantomograms before and after reduction.

mination of the exact site of the foreign body. Measurements on the film-holder may serve the same purpose. Re-examinations after surgical management can be made in practically unchanged projection and without undue waste of time. Metal fittings, such as implants, are excellently demonstrated. Stereoscopic views seem to be particularly valuable in these instances.

III. *Tumors and Cysts:* There is a considerable difference in the pantomographic evaluation of benign and malignant tumors of the jaws. Benign tumors are often of fair size, with distinct margins, causing marked alterations in the osseous structure, as compared with the normal bone. On a pantomogram, these features

involved and with the special procedures for their demonstration assist in overcoming these difficulties. In addition, it is characteristic of pantomography that only one projection is available; no projections comparable with routine intra-oral or axial views are possible.

(a) *Benign Tumors and Cysts.* Roentgen features of maxillary and mandibular cysts are such that diagnosis and differential diagnosis are warranted pantomographically. A tooth, tooth fragment, or even a small odontoplastic rudiment is apparent in contrast to the radiolucent cyst contents. Where the borderlines are sclerotic, the tomographic effect produces sharp definition of the contour of the cyst. The re-

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relationship between the cavity and the tooth is revealed in detail. Deformities of the jaws caused by excessive growth can be judged against involved borderlines, or stereoscopically.

In embryonal development, the tissues of the oral cavity are of manifold origin;

pantomograms than on conventional films. The location and extent of the involvement are evaluated by means of appropriate anatomical landmarks. Significant minimal changes, especially malignant change in an originally benign tumor, require special attention and experience with

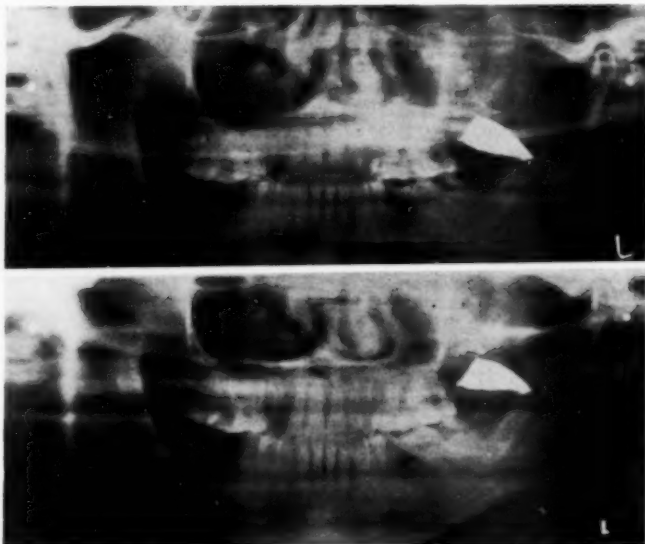


Fig. 4. Metallic foreign body in the region between the left mandible and maxilla. Stereoscopic pair.



Fig. 5. Resection and transplantation of new bone for an adamantinoma of right mandible.

this is reflected in the structure and behavior of the tumors of this region. Those arising from the normal osseous tissue follow the pattern of other osteogenic tumors, while odontogenic tumors form a special group. Benign tumors, particularly those of odontogenic origin, are better shown on

this method. The tomographic effect is most helpful, and can be increased by diminishing the depth of the image layer. It is possible that conventional lamina-graphic procedures become superfluous with the examination of the jaws by this method.

(b) *Malignant Tumors.* Primary malignant lesions and metastatic involvement of the jaws do not seem to be suitable for pantomography. Small initial changes may be unavoidably blurred and poorly defined. The advantages of the method, however—easy placement of the patient

IV. *Inflammatory Changes; Necrosis:* Difficulties in differential diagnosis of malignant tumors and inflammatory processes in conventional radiography of the jaws apply also to pantomography, though the latter procedure may have slight advantages when changes are of a somewhat



Fig. 6. Cyst of the left maxilla.

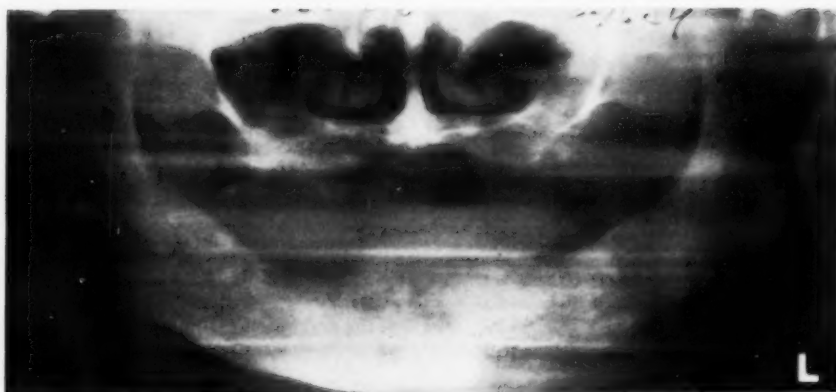


Fig. 7. Metastatic osteolytic destruction of the left half of the mandible.

and demonstration of the entire jaw—make serial examinations at short intervals practicable. Experience has shown that, while a single pantomogram may be difficult to interpret, consecutive films often allow a positive conclusion. Carcinomas, sarcomas, and mixed tumors, producing osteolysis, new-bone formation, sclerosis, and periosteal changes, can be accurately evaluated by this means. Soft-tissue masses, cavities, and cysts within the tumor are often revealed by the tomographic effect.

distinct nature. Sequestered bone in an osteomyelitic focus or increased calcium within an area of healing may be better recognized on a pantomogram. It has been possible to diagnose radiation necrosis in cases where metastatic involvement had been suspected. Again, the simplicity of the procedure is to be emphasized, in manipulation of severely ill patients.

SUMMARY

Attention is called to the value of pantomography in examination of the jaws.

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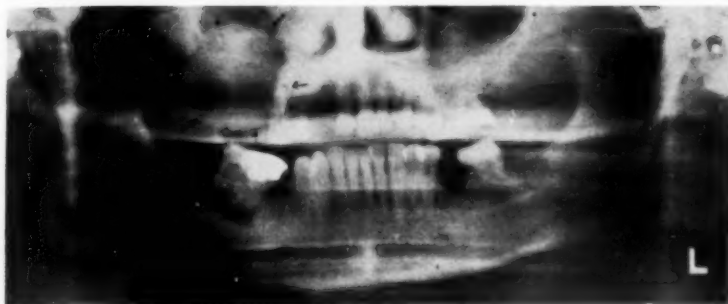


Fig. 8. Carcinoma of the right maxilla, outgoing from the maxillary sinus.



Fig. 9. Osteomyelitis of the left mandible near the angulus.

The pantomographic image is described and methods of refining the examination by special procedures are pointed out. Pantomography seems to be most valuable in cases where pathologic changes are sufficiently extensive, or otherwise distinct, so as not to be disturbed by shadows due to the tomographic effect. On the other hand, it is possible that conventional tomography will be superseded as a result of the superior definition obtained in pantomograms. Further advantages of the method are easy handling of the patient and the possibility of re-examination in unchanged projections.

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SUMARIO

La Pantomografía Clínica de las Mandíbulas

Llámase la atención sobre el valor de la pantomografía en el examen de los maxilares. Se describe la imagen pantomográfica de las mandíbulas y se sugieren métodos para perfeccionar el examen con procedimientos *ad hoc*. La pantomografía parece alcanzar su mayor valor en los casos en que las alteraciones patológicas son suficientemente extensas, o sino, acentuadas, para que no las perturben las sombras del efecto tomográfico. Por otro lado, es posible que la

tomografía corriente se vea suplantada por virtud de la definición superior obtenida en los pantomogramas. Otras ventajas del método estriban en la fácil manipulación del enfermo y la posibilidad de hacer re-exámenes en proyecciones inalteradas.

Se define la pantomografía como procedimiento para la obtención de laminogramas de superficies curvas, que emplea un foco fijo de radiación, mientras que el objeto y la película rotan a velocidades iguales.



Ultrasoft Roentgen Rays in the Treatment of Hemangiomas

A Follow-up Examination of 400 Cases of Strawberry Marks and Port-Wine Stains¹

E. AMDRUP, M.D., and G. KNUDSEN, M.D.

THE MANAGEMENT OF cutaneous hemangiomas is a much debated subject. Opinions diverge, both as to the need of any treatment at all to these benign blood-vessel tumors and as to the choice of possible therapy and the time at which it should be instituted.

It is generally agreed that some hemangiomas undergo spontaneous involution. For this reason, Lister (33) expressed the view that treatment is indicated only in exceptional cases. Many investigators, however, agree with Traub (46), who believed that spontaneous regression is relatively rare, so that treatment during the first year of life must be recommended.

On the basis of their comprehensive case material, Watson and McCarthy (48) concluded that all hemangiomas should be treated as early as possible, an opinion which most writers share. The reasons for this attitude are:

(a) It is impossible to predict whether a particular hemangioma will disappear spontaneously or continue its growth, and the size of the ultimate scar will increase with that of the hemangioma (1).

(b) "Spontaneous" regression frequently occurs after ulceration and infection of the hemangioma, with resultant scarring usually more conspicuous than that following proper treatment.

(c) Although serious complications are relatively rare, the dangers of sepsis and profuse hemorrhage must be taken into account.

(d) Radiosensitivity decreases with age. Thus, if a "wait and see policy" is adopted until spontaneous regression is no longer likely, the radiation dose required must be increased with an ensuing drop in the chance of a satisfactory cosmetic result.

If the view that treatment should be

given in all cases is adopted, the cosmetic result should be at least as good as the best observed after spontaneous retrogression. The treatment employed must make the hemangioma disappear, leaving only a slight scar; it must, at the same time, be harmless to the normal tissue underlying the tumor and without risk of secondary radionecrosis.

Various methods of treatment have been described, including surgical removal, injection of sclerosing solutions (13) or of materials producing infection (*e.g.*, cowpox vaccine), and radiation therapy. Radium (1-4, 9, 10, 21, 23, 31, 36, 37, 41, 45-48) and roentgen (25, 26, 30, 32, 38-40) radiation each has its advocates.

The hazard inherent in radiation therapy of hemangiomas consists in excessive exposure of the underlying structures. Various writers have warned against irradiation of lesions situated on the lips or genitalia, near epiphyseal lines (in particular of fingers and toes), in areas adjacent to the eyes or close to granular tissue, in the thin skin over the mid-line areas of the sternum and vertebrae, and on the scalp (13, 35, 41, 42, 48). Radiation damage has been reported in the skin (2, 12), developing dental tissue (43), breast (47), cerebrum (31), and lens (48).

ULTRASOFT ROENTGEN RAYS

In 1928, Bucky (6-8) published his first studies on the "grenz rays," which now bear his name. These rays were produced by a Bucky tube with a Lindemann window at voltages of 7 to 12 kv, with a half-value layer of 0.1-0.4 mm. of skin. These very soft rays are used extensively by dermatologists in the treatment of eczema.

Most cutaneous cancers, chronic ulcera-

¹From the Department of Radiology, the Town and County Hospital, Kolding, Denmark. Accepted for publication in May 1955.

tions, and hemangiomas are too thick for effective therapy with Bucky rays. Some radiologists treat these lesions with hard rays and fractionated dosage, but in general softer qualities of radiation (45 to 90 kv), given as contact therapy by the technic described by Chaoul and Adams (1933) and van der Plaats (1938), are preferred. This practice, however, may also involve dangers. Pendergrass (38) pointed out that cartilage tolerates short-distance irradiation poorly. After calling attention to the hazards of radiation damage to hands and feet following contact roentgen therapy at 45 to 90 kv, Poppe (42) observed that "it would be an advantage to have an apparatus which could be operated at a lower voltage than that of Philips, for example, down to 20 kv, so that an even greater fall of intensity with depth could be obtained."

As early as 1936, Ebbehøj recommended that rays of softer quality, produced at voltages of 10 to 30 kv, should be used in the treatment of skin cancers which, after scraping, were less than 2 mm. thick. Such rays are harder than Bucky rays, but appreciably softer than those used in Chaoul therapy. Ebbehøj, who introduced them into therapeutic radiology, called them ultrasoft rays. In subsequent papers he considered their physical properties (17, 19, 20) and outlined their clinical possibilities (14-16, 18). The same radiation qualities have been studied by Jennings (27-29), Green (22), and Hendtlass (24).

Ebbehøj characterized the ultrasoft rays by the voltage at which they are produced and by their half-value layer. Paraffined paper was used as phantom material in measurements of the half-value layer, and it was shown that this material in its absorptive qualities for ultrasoft rays closely corresponds to shaved ears of mice and rabbits (17). Accordingly, the half-value layer for these rays was stated in terms of millimeters of skin, the maximum being 2 mm.

Ebbehøj's considerations were based upon the assumption that the layers im-

portant to the nutrition of the skin are situated at a depth of about 3 mm. In order to avoid radionecrosis, it is of the greatest importance, therefore, that as little of the roentgen dose as possible reach this "dangerous depth."

Most superficial lesions may be reduced to a thickness of 1 to 2 mm., by scraping in the case of skin cancers and by compression of hemangiomas. In treating lesions of this thickness there is no reason to use radiation qualities harder than ultrasoft rays. By measurements and comparison of depth-dose curves for ultrasoft rays and some of the harder rays in common use, Ebbehøj (19) demonstrated that the former give a greater safety factor, *i.e.*, the range of therapeutic effect is wider than that of the slightly harder radiation qualities. In other words, the advantage of ultrasoft rays is that, even when a completely adequate dose is delivered to the superficial lesion, only a minimal amount will reach the deeper, unaffected tissue; the danger of secondary radionecrosis is diminished, with a corresponding increase in the chances of a good cosmetic result.

Ultrasoft roentgen rays have proved to be useful in the treatment of cutaneous cancers less than 2 mm. in thickness after scraping (14-16, 18, 34, 44); the treatment is effective, and satisfactory cosmetic results are obtained. *No radionecrosis was encountered* after an observation period of fourteen years.

CASE MATERIAL

A total of 402 hemangiomas in 339 patients were treated during the years 1940 to 1952: 315 were elevated, while the remaining 87 were flat. The series consisted of 231 females and 108 males. Hemangiomas with measurements of 1.5×1.5 cm. or less were classified as "small," those exceeding 2.5×2.5 cm. were described as "large," while intermediate lesions were listed as "medium-sized."

It has always been the policy of our department (Department of Radiology, Town and County Hospital, Kolding, Denmark) to follow the patient until

the lesion has completely disappeared. There have been some failures, however, to report for follow-up examination. For the purpose of this final analysis of results, a questionnaire accompanied by an invitation to return for a follow-up examination was sent to all the patients.

Patients with 241 hemangiomas were examined in person. In 155 cases, information was received as to the present state of the hemangiomas in the form of replies to the questionnaire. The evaluation of results in the latter cases was made by comparison with the clinical records. All of these patients had previously returned for examinations, for one to two years after the conclusion of treatment. Only 4 patients, with 6 hemangiomas, failed to answer the questionnaire, but in these instances the information contained in the clinical records was so detailed (with photographs) that the cases could still be included in the analysis.

CLASSIFICATION OF HEMANGIOMAS

The hemangiomas were not studied histologically, so that our classification is based on purely clinical characteristics:

Flat hemangiomas

- Nevus araneus (stellate or telangiectatic angioma).
- Nevus simplex.
- Nevus flammeus (nevus vinosus or port-wine stain).

Elevated hemangiomas

- Strawberry marks.
- Cavernous hemangioma.

Nevus araneus was treated by electrocoagulation of the central vessel.

In agreement with Traub (46), we understand nevus simplex to refer to the flat red spots seen in a large number of newborn infants in the area of the occipital protuberance and, sometimes, on the skin over the glabella. Since these marks almost always disappear spontaneously without leaving any scar, treatment is not indicated.

All the flat hemangiomas in this series were port-wine stains. No cases of purely cavernous hemangioma (the subcutaneous, easily compressible tumor imparting a

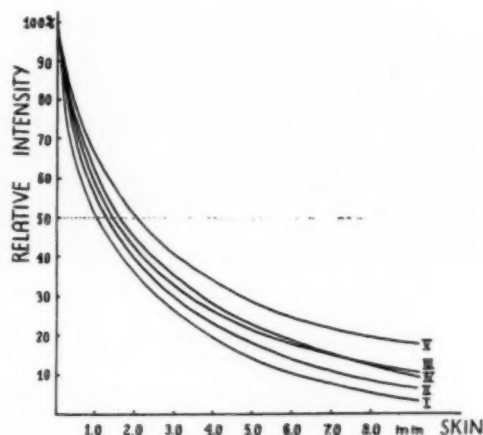


Fig. 1. Curve I, 20 kv, h.v.l. 1.05 mm. skin. Curve II, 30 kv, h.v.l. 1.35 mm. skin. Curve III, 30 kv, h.v.l. 1.43 mm. skin. Curve IV, 30 kv, h.v.l. 1.6 mm. skin. Curve V, 30 kv, h.v.l. 2.01 mm. skin.

bluish appearance to the skin) were observed. All of the elevated hemangiomas treated were strawberry marks; these may be purely superficial or may contain a deeper, presumably cavernous element. No distinction between these two types was made in the present study.

Histologically, both strawberry marks and port-wine stains are classified as capillary hemangiomas, but while the elevated lesions reveal a poorly differentiated endothelium, the cells of the flat hemangiomas are of adult type. This explains the considerably higher radiosensitivity of the strawberry marks.

TECHNIC OF IRRADIATION

During the period 1939-45, a Siemens tube was used, giving a beam with a half-value layer of 2.02 mm. of skin at 30 kv and of 1.15 mm. of skin at 20 kv. Most elevated hemangiomas were treated at 30 kv, while the thinnest strawberry marks and flat hemangiomas received the softer radiation.

Since 1945, we have used a Machlett tube with a beryllium window, with a focus-skin distance of 10 cm. Depth-dose curves and radiation factors are shown in Figure 1.

A few hemangiomas were treated with Bucky rays, usually in fractionated dosage,

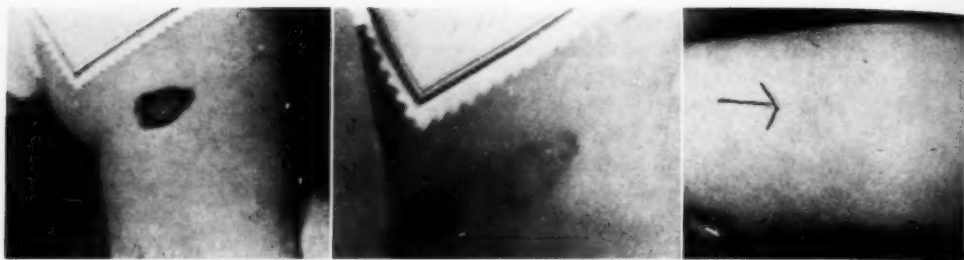


Fig. 2. Hemangioma treated at 30 kv, h.v.l. 1.35 mm. skin: 900 r on Aug. 24, 1948; 800 r on Feb. 21, 1949.



Fig. 3. Lesion treated at 30 kv, h.v.l. 2 mm. skin: 800 r on May 2, 1953; 800 r on Sept. 4, 1953.

with 500 r at each sitting. Except in these few cases, a large single dose was given. At present we invariably use a single dose of 800 to 1,200 r.

The adjacent unaffected skin is protected by a thin shield of lead foil, 0.1 to 0.3 mm. in thickness, which is sufficient to stop the beam of ultrasoft rays. A hole corresponding to the form and size of the hemangioma is cut in the lead foil. In order to avoid unsightly pigmentation at the periphery of the hemangioma, the use of such a shield is urged.

Flat hemangiomas are irradiated directly, without compression. On the other hand, elevated hemangiomas must be compressed during the exposure. Otherwise the abundant amounts of blood present in these lesions will absorb a large proportion of the ultrasoft rays, resulting in an undue difference in the dose delivered to the surface and that reaching the deeper portions.

Compression is carried out by a sheet of roentgen film from which the light-sensitive

emulsion has been washed off. This film is placed on the side of the lead shield facing the hemangioma, and the shield is fixed by adhesive tape. So as to provide sufficient rigidity for compression, the shield under these circumstances is made of foil 1 mm. thick. Compression is not only an essential part of the treatment, but, in addition, it equalizes the thickness of the various hemangiomas to such an extent that it is possible to standardize the choice of doses and radiation qualities. In the calculation of the dosage it must be considered that a portion of the ultrasoft rays is absorbed by the film. The film used by us is 0.2 mm. thick, absorbing approximately 17 per cent of the dose at 30 kv with h.v.l. of 1.6 mm. of skin.

In the past two years we have used for the most part a Philips contact unit with a mica beryllium window. When small hemangiomas are treated with this unit, the radiation factors are: 2 cm F.S.D., 30 kv, and h.v.l. 1.35 mm. of skin (Fig. 1). At this distance the unit has the advantage of

allowing compression to be carried out by the watchglass-shaped end of the roentgen tube. In the application of this technic the 0.1 mm. lead foil found in dental film packs is used as a shield. This foil is readily workable and gives sufficient protection. With a beam produced at 30 kv, with a half-value layer of 1.35 mm. of skin, less than 0.2 per cent of the dose applied penetrates the foil, which is fixed to the skin by a thin layer of mastic solution.

If a hemangioma larger than 2×2 cm. is treated with the Philips contact therapy unit, the focus-skin distance must be 4 cm. to give a sufficiently large field. At 30 kv the beam has a half-value layer of 1.6 mm. of skin. At this distance, film compression must be used.

Small hemangiomas rarely required more than one treatment, while for medium-sized and large lesions often two or occasionally three treatments were necessary. More than three exposures of 800 to 1,200 r were never given.

The patient is instructed to return for examination ten to fourteen days after therapy. A very slight reaction is then seen and the hemangioma usually shows distinct signs of regression. The treatment is not repeated until regression induced by the preceding exposure has ceased, and an interval of at least four months is always allowed between exposures.

COSMETIC RESULTS

Following treatment, some hemangiomas disappeared without leaving any scar, so that the former site of the lesion could not be located (Fig. 2). Others left a very slight scar, in the form of a small depigmented or pink spot, visible to those familiar with the case history but otherwise unrecognizable. These results were classified as "excellent."

Other hemangiomas disappeared completely, leaving behind a distinct but non-disfiguring scar (Fig. 3). The treated area was distinctly visible, due to some depigmentation, possibly with a few tiny telangiectases or slight marginal pigmentation, but the skin was soft and without sclerotic



Fig. 4. Hemangioma treated at 30 kv, h.v.l. 2 mm. skin: 1,400 r on Jan. 29, 1941. This is the poorest result obtained in the entire series.

changes. In these cases and in those showing slight residual hemangioma, the results were considered "good."

Finally, some lesions disappeared, but left disfiguring scars (Fig. 4), with more distinct telangiectases or more intense pigmentation and some cutaneous sclerosis. Such cases were classified, together with those in which either a disfiguring remainder was present or the lesion remained unchanged after treatment, as "less satisfactory."

In some instances, scarring was attributable to pretherapeutic ulceration and infection of the hemangiomas.

Treatment may result occasionally in slight pigmentation of a marginal area, but this will usually fade in the course of a couple of years, more rapidly and completely in blond than in brunet individuals. Not only this pigmentation, but also small remainders of the hemangiomas, have been seen, on follow-up examination, to disap-

TABLE I: RESULTS OF TREATMENT OF 315 STRAWBERRY MARKS AS RELATED TO SIZE OF THE HEMANGIOMA

| Size | Classification | | | | | Total |
|--------------|----------------|----|-----|----|----|-------|
| | A + B + C | D | E | F | G | |
| Small | 10 | 69 | 58 | 32 | 2 | 171 |
| Medium-sized | 14 | 19 | 44 | 23 | 4 | 104 |
| Large | 7 | 10 | 12 | 7 | 4 | 40 |
| TOTAL | 31 | 98 | 114 | 62 | 10 | 315 |

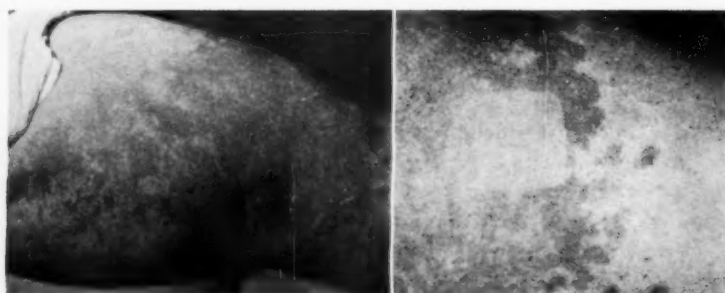


Fig. 5. Hemangioma treated at 20 kv, h.v.l. 0.9 mm. skin: 1,200 r on March 22, 1944. The last photograph was taken on July 14, 1945. The lesion was a large port-wine stain, of which the portions reaching down below the patient's knickers were first treated with good effect. Later, Ebbelhøj was allowed to treat a field in the middle of the large hemangioma, and it was planned to treat the small peripheral portions afterward. However, we did not see the patient until she returned for follow-up examination. In the meantime she had married and (therefore?) considered further treatment unnecessary!

pear in the course of time. The latter observation is in agreement with that of Thomas and Fjeldborg (45). In general, the scars became more invisible in the course of years. Superficial strawberry marks left a scar at the level of the skin, if at all. If there had originally been an appreciable subcutaneous element, a slight depression was usually present at the site, rarely visible but distinctly palpable.

As already mentioned, many writers warn against radiation therapy of hemangiomas of the scalp because of the danger of permanent loss of hair in the irradiated area. In most instances in our series hair failed to return at the treatment site and in a narrow surrounding zone, but cases were seen in which regrowth of hair did take place at the location of the former lesion. Alopecia exactly similar to that following irradiation has recently been observed in association with a medium-sized hemangioma of the scalp in spontaneous regression. Even in the narrow marginal zone there was absence of hair. We are there-

fore not convinced that alopecia is always to be ascribed solely to treatment.

RESULTS OF TREATMENT OF STRAWBERRY MARKS

The results of treatment of 315 strawberry marks, as disclosed by the answer to the questionnaire and by the follow-up examination, were classified as follows (2 cases receiving further treatment elsewhere are excluded):

A. Unchanged, 5 (2 seen at the follow-up examination in 1954).

B. Disfiguring residual lesion, 12 (2 seen at follow-up in 1954).

C. Slight, visible residual lesion, 12 (8 seen at follow-up).

D. Complete disappearance with no scar, 98 (55 seen at follow-up).

E. Complete disappearance with slight scar, 114 (83 seen at follow-up).

F. Complete disappearance with distinct, non-disfiguring scar, 62 (32 seen at follow-up).

G. Complete disappearance with dis-

TABLE II: SURVEY OF 270 OF THE 284 STRAWBERRY MARKS WHICH DISAPPEARED COMPLETELY, *i.e.*, THE GROUPS D, E, F, AND G, AS RELATED TO H.V.L. IN MILLIMETERS OF SKIN

| Size (site) | h.v.l. < 2 mm. | | h.v.l. > 2 mm. | | Total |
|----------------|----------------|-------|----------------|-------|-------|
| | D + E | F + G | D + E | F + G | |
| Small | | | | | |
| On the face | 33 | 6 | 21 | 5 | 65 |
| At other sites | 60 | 6 | 12 | 15 | 93 |
| Medium-sized | | | | | |
| On the face | 7 | 1 | 7 | 0 | 15 |
| At other sites | 37 | 8 | 9 | 14 | 68 |
| Large | | | | | |
| On the face | 0 | 0 | 0 | 0 | 0 |
| At other sites | 17 | 2 | 5 | 5 | 29 |
| TOTAL | 154 | 23 | 54 | 39 | 270 |

figuring scar, 10 cases (7 seen at follow-up).

Results classified as D and E, representing 212 lesions (67.7 per cent), are considered excellent. One hundred and thirty-eight of this number (73 per cent) were seen at the follow-up examination in 1954. Groups C and F, representing 74 lesions (23.7 per cent) are considered good; 40 of these cases (21.2 per cent) were seen at follow-up. Groups A, B, and G, numbering 27 (8.6 per cent), are regarded as less satisfactory. Eleven (5.8 per cent) from these latter groups were seen at follow-up.

Three cases unchanged by irradiation were later subjected to surgical treatment. Six cases with disfiguring residual lesions were subsequently given further roentgen treatment.

In 14 cases, ulceration and infection had developed before the institution of treatment. In 4 of these the scar was slight, in 10 distinct.

As might be expected, the cosmetic results were most satisfactory following treatment of small hemangiomas. An excellent result was obtained in about 74 per cent of these, as compared with about 60 per cent of lesions of medium size, and 50 to 60 per cent of the larger ones (Table I). The present material does not show any relation between scarring and location of the hemangioma.

To elucidate the importance of the half-value layer in the ultimate cosmetic result, the cases in which the hemangiomas had completely disappeared (Groups D, E, F, and G) were analyzed. The 14 cases in which previous ulceration and infection

may have played a role in the ultimate cosmetic result were excluded, leaving a total of 270 cases to be evaluated.

As shown in Table II, these 270 hemangiomas are divided into two groups: those treated with ultrasoft rays having a half value layer of less than 2 mm. of skin and those treated with ultrasoft rays having a half-value layer of 2 mm. of skin or even harder rays. Excellent results were obtained in 208 cases (D and E); distinct (F) or disfiguring scars (G) were present in 62.

It appears that the softer qualities of radiation produced highly superior results. In addition, it should be noted that all the *less satisfactory results (Group G) were obtained after treatment with rays having a half-value layer of at least 2 mm. of skin.* An attempt was made to determine whether the lesions in Groups F and G in which the harder radiation was used had received a relatively larger dose or whether the age distribution was less favorable than in other groups, but neither proved to be the case.

Definite conclusions cannot be drawn on the basis of the present limited material, but the results tend to support Ebbehøj in his emphasis on the advantages of ultrasoft rays in the treatment of superficial lesions which can be reduced to a thickness of about 2 mm. or less. Our evidence indicates that this therapy is as effective as that in which a harder quality of rays is employed.

The patients were asked if they were satisfied with the cosmetic result. The answer was in the affirmative in 283 cases,

TABLE III: RESULTS OF TREATMENT OF 86 PORT-WINE STAINS AS RELATED TO SIZE OF LESION

| Size | Classification | | | | | | | Total |
|--------------|----------------|---|----|----|----|---|---|-------|
| | A | B | C | D | E | F | G | |
| Small | 7 | 1 | 5 | 23 | 10 | 1 | 0 | 47 |
| Medium-sized | 2 | 5 | 9 | 1 | 4 | 2 | 0 | 23 |
| Large | 1 | 3 | 8 | 4 | 0 | 0 | 0 | 16 |
| TOTAL | 10 | 9 | 22 | 28 | 14 | 3 | 0 | 86 |

11 patients were dissatisfied, and in 21 instances no response was obtained.

RESULTS OF TREATMENT OF PORT-WINE STAINS

A total of 87 port-wine stains in 73 patients were treated (Table III). One case, given further treatment elsewhere, was excluded from the survey. The results, grouped according to the same classifications as that employed for the strawberry marks, with 52 seen at follow-up, were as follows:

A. Ten cases, with 5 seen at the follow-up examination.

B. Nine cases, with 6 seen at follow-up.

C. Twenty-two cases, with 9 seen at follow-up.

D. Twenty-eight cases, with 19 seen at follow-up.

E. Fourteen cases, with 11 seen at follow-up.

F. Three cases, with 2 seen at follow-up.

G. No cases.

Radiation therapy of port-wine stains is usually not recommended. We have no experience with other forms of treatment, but as appears from the figures, satisfactory results may be obtained by ultrasoft rays.

The majority of the lesions considered here were treated with a beam produced at 20 kv, h.v.l. 1 mm. of skin. A single dose of 1,000 to 1,200 r was given without compression and after careful shielding. More recently we have for the most part used a beam having a half-value layer of 1.35 to 1.43 mm. of skin (Fig. 1). The results do not seem to differ from those previously obtained, but the number of hemangiomas treated with these qualities is as yet relatively small.

Small hemangiomas most frequently disappeared, leaving only a slight scar or none

at all after one or, at most, two treatments given at an interval of four months or more; with this mode of treatment large hemangiomas became less conspicuous (Fig. 4).

No scar formation was encountered in the irradiated area after a single dose of 1,000 to 1,200 r. After two administrations of this dose, very slight atrophy usually developed, and three exposures resulted in a slightly more distinct scar. No more than three treatments have been given to the same field, even though the patients often expressed a desire for additional irradiation.

Fifty-nine patients were satisfied with the result, while 17 were dissatisfied, not with the scarring, but with failure of the hemangiomas to disappear completely.

In follow-up of the port-wine stains no disappearance of residual lesions was observed. The hemangiomas were found to be entirely unchanged as compared with the appearance several years earlier.

SUMMARY AND CONCLUSIONS

Ultrasoft rays have been found to be suitable for the treatment of both flat and elevated hemangiomas. They may be given to all superficial hemangiomas, irrespective of their location. The technic is simple and the administration rapid, requiring a few seconds up to a few minutes. This is an obvious advantage, especially in the case of a young, restless child. Careful shielding of the surrounding, unaffected tissue is important. Flat lesions are irradiated directly; for the elevated variety, compression must be used.

Radiation with a half-value layer of less than 2 mm. of skin is to be preferred. The radiation factors at present most frequently employed by the authors are: 30 kv and 1.35 or 1.43 mm. of skin. For flat

hemangiomas, it may be of advantage to use a still lower voltage, as 20 kv with a half-value layer of 1.01 mm. of skin. The dose of 800 to 1,200 r is given in one sitting and is not repeated until after a lapse of at least four months.

A series comprising 315 elevated and 87 flat hemangiomas is reported. For these cases the radiation was produced at 20 to 30 kv, with a half-value layer of 1.0 to 2.0 mm. of skin. The treatment proved to be as effective as irradiation with a harder beam and the cosmetic results were superior. No instance of radionecrosis was encountered on follow-up examination.

The technic of treatment is described and the results are analyzed. For an account of the physical properties of ultrasoft rays the reader is referred to publications by Ebbenhøj.

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SUMARIO

Los Rayos X Ultrablandos en el Tratamiento de los Hemangiomas. Examen Subsiguiente de 400 Casos de Nevos Pigmentarios (Lunares Frambuesiformes y Manchas Vinosas)

Se comunica el empleo de rayos X ultrablandos en el tratamiento de hemangiomas; 315 de las lesiones eran elevadas (lunares frambuesiformes) y 87 planas (manchas vinosas). Se describe la técnica de la terapéutica y se presentan los resultados.

La calidad de la radiación empleada se produjo a 20 a 30 kv, con una capa de hemirreducción de 1 a 2 mm. de piel. La dosis fué de 800 a 1,200 r, sin que se repitiera

el tratamiento en un plazo a lo menos de cuatro meses. Recálcase la importancia del cuidadoso resguardo del tejido indemne circundante e igualmente de la compresión de los hemangiomas elevados durante la irradiación.

El tratamiento resultó eficaz y se obtuvieron excelentes resultados estéticos. En el examen subsiguiente no se encontró ningún caso de radionecrosis.



Carcinoma of the Posterior Tongue Treated with Radiation¹

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IT IS CUSTOMARY to group primary lingual carcinomas according to their site of origin. The most frequent locations are the lateral border, the base, and the anterior tip of the tongue, in that order (1). Most authors define that portion of the tongue limited anteriorly by the circumvallate papillae and posteriorly by the valliculae as the "base" (2). Tumors growing in this region are, at times, included in discussions of oropharyngeal and hypopharyngeal tumors, which occur in close anatomical proximity. Since the embryological formation of the posterior tongue enjoys a different origin from the anterior two-thirds, the two regions may have different tissue characteristics, and tumors arising in the base have been said to be more anaplastic (3).

In this study, tumors of the extreme posterolateral tongue are considered with lesions of the true base, as defined above, in order to evaluate problems common to both regions. Outstanding among these problems are the difficulties in early diagnosis and the obstacles in the pathway of an adequate therapeutic approach.

A persistent, although non-tender, mass in the free portion of the tongue can usually be detected early by the patient, and this often is the chief complaint leading him to his doctor. A similar process on the posterior tongue may remain out of sight, undetected and undisturbed for an unknown period of weeks or months, and may extend to adjacent areas and release emissary cells to lymph nodes in one or both sides of the neck before discovery. Local ulceration complicated by infection and pain characteristically direct attention to the fact that something is wrong. A sore throat, with attendant difficulty in swallowing, and a "kernel" in the neck are

common findings in general practice and are often treated symptomatically, on the assumption that they are due to a simple infection, until persistence dictates more complete examination. A frequent symptomatic pattern associated with posterolateral tongue lesions is pain in the posterior jaw with radiation into the ear, face, and temple on the side of involvement. One cannot place too much stress on the importance of indirect mirror examinations and direct finger palpation of the posterior tongue in the presence of these complaints.

The relative inaccessibility of the region accounts for the lack of a standard approach in therapy. External irradiation is among the most frequent methods employed (4, 5), but it may be poorly directed even when large treatment fields are used if the therapist conducts only a hurried preliminary examination. The difficulties inherent in directing intraoral cone therapy with accuracy are evident. Complete surgical extirpation of the lesions requires a highly skilled and courageous surgeon. When excision includes a portion of the pharynx and mandible, or when tracheotomy and laryngectomy are necessary to avoid dangers of aspiration, the functional and cosmetic results often leave much to be desired. Since the incidence of cervical metastases is high, surgical neck dissections will be frequent additions to the method, either therapeutically or "prophylactically."

ETIOLOGY

Etiologic factors presumably associated with tongue cancer vary in their frequency, and hence in their importance, from one series to another. Whereas most reports record a significantly high association of syphilis, this was not true of our series.

¹ Presented at the Forty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 11-16, 1955.

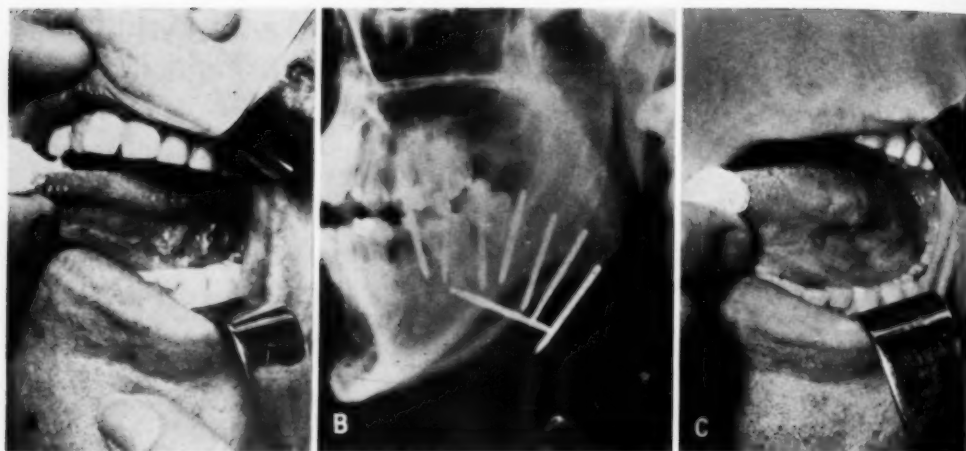


Fig. 1. Flat squamous-cell carcinoma, Grade 2, involving the posterior and lateral tongue with extension to the lateral floor of the mouth. B. X-ray demonstration of the radium needle pattern. C. Primary healing two months after therapy. Note that the teeth have not been disturbed.

In fact, only one patient actually required treatment for frank syphilitic glossitis. The glossitis of Plummer-Vinson's syndrome, which apparently predisposes to a significant incidence of cancer of the tongue in Swedish women (5), is not an obvious factor in this country. Fraser in Scotland (6) observed a high incidence of cancer of the tongue in localities where the consumption of "raw spirits" is high, and Jacobsson in Sweden found excessive alcohol consumption to be "rather more typical" in those patients with tumors arising in the tongue base. It has been our impression, also, particularly in recent years, that alcoholism is more common in patients with posterior tongue lesions than in other patients seen in the tumor clinic. This leads one to speculate as to whether a long standing avitaminosis with attendant glossitis from chronic alcoholism may indeed cultivate fertile ground for an epithelial new growth. The chronic irritation produced by heavy smoking, jagged teeth, or poor fitting dentures is probably of more etiologic significance, since these factors are conspicuous in most studies, including the present one. The habit of snuff dipping enjoyed in the rural sections of the Southwest by many older women plays a similar irritative role, par-

ticularly in the formation of leukoplakia and carcinoma of the lateral tongue, sulcus, and buccal mucosa.

MATERIAL

In the period from 1936 to 1950, a total of 120 cases of primary carcinoma of the tongue have been seen in our clinic. Forty of these, 33.3 per cent, involved the posterior third of the tongue and represent the material for this study. Males outnumbered females, roughly two to one. Most patients were in the age range between fifty and eighty years, the youngest being thirty-two years of age and the oldest eighty-four.

METHOD OF TREATMENT

All patients were treated primarily with irradiation technics employing low-intensity radium needle implantation of the primary tumor, as described in previous reports (7, 8). Lymph node metastases, when present, were treated by interstitial radium implants combined with heavily filtered x-ray therapy with conventional 220-kv equipment (9). Radical surgery as a primary approach has not been used in any instance.

Adequate atropinization and local anesthesia are imperative if one is to obtain

good access to the posterior tongue for radium needle implantation. As a rule, lesions located in the true base of the tongue are treated by the vertical implantation of needles containing 2.4 mg. of radium distributed in 4.0 cm. of active length. This procedure is not too difficult

the production of proper needle patterns in these irregular areas, and a certain amount of clinical judgment and experience are essential.

One is impressed by the relative superiority of palpation under anesthesia over visualization in mapping the outlines of

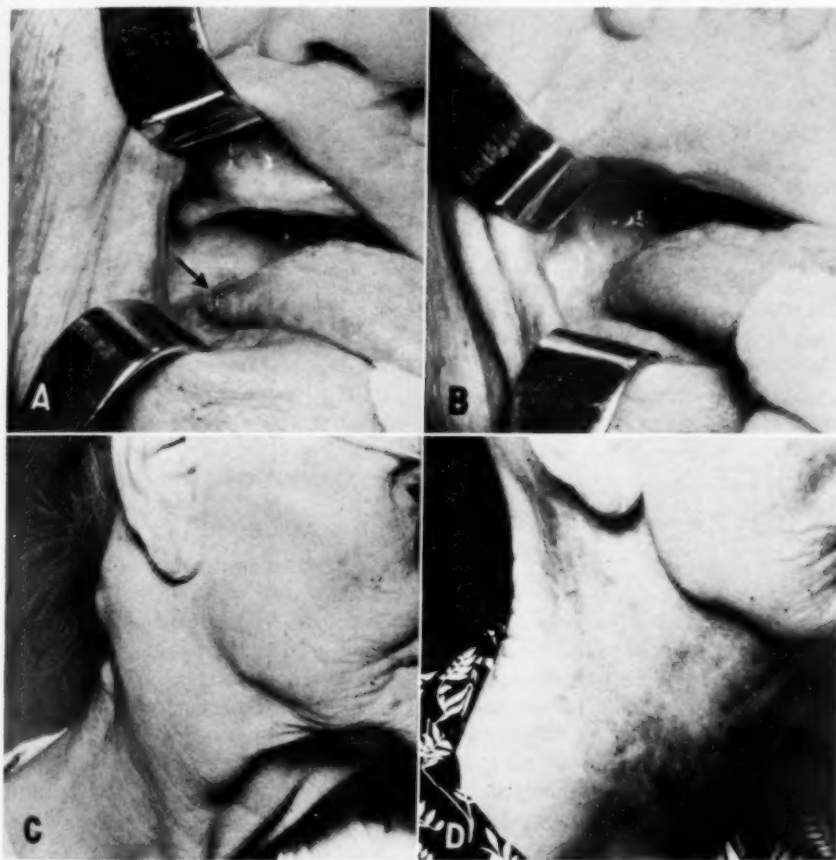


Fig. 2. A. Mass measuring 2.0×2.5 cm., well back in the right posterior tongue (arrow). Biopsy revealed squamous-cell carcinoma. B. Appearance three months after therapy. C. Large mass of cervical metastases in the right upper neck, with complete regression (D) three months after radiation therapy.

when the patient is properly prepared and the tongue is held down firmly with a long curved metal tongue depressor. Tumors on the posterior lateral border and extensions into the floor of the mouth and sides of the pharynx are implanted with needles containing 1.33 mg. of radium in 1.5 cm. of active length. Prompt healing and the prevention of sloughs depend on

these tumors, particularly when extension has occurred downward into the valleculae. Our preconceived needle patterns are often changed at the operating table after a proper examination is carried out.

All patients are hospitalized for a week while the radium is in place, during which time symptomatic and supportive care add significantly to comfort and uneventful

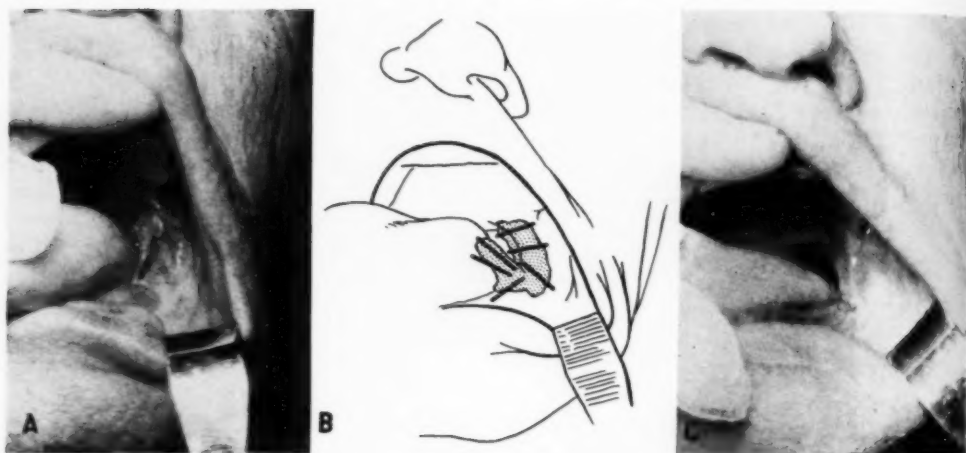


Fig. 3. A. Squamous-cell carcinoma, medium grade, of the posterolateral tongue with extension into the lateral floor of the mouth and into the anterior tonsillar pillar is shown on the left. B. Radium needle pattern. C. Healed tongue and pharynx nine months after therapy.

TABLE I: CARCINOMA OF THE POSTERIOR TONGUE: SURVIVALS

| | Total Cases | Five-Year Survivals |
|---------------------------------|-------------|---------------------|
| Patients without palpable nodes | 18 | 10 (56%) |
| Patients with palpable nodes | | |
| On admission | 14 | 3 (23%) |
| Later | 8 | 2 (25%) |
| TOTAL | 40 | 15 (38%) |

convalescence. Local infections in ulcerated lesions can be controlled by mouth washes, frequent applications of mercurochrome, and the addition of antibiotics when indicated. Pain and sleeplessness are relieved by medication. If edema of the posterior tongue is of such degree as to prevent swallowing, fluids can be administered intravenously for a day or two until the patient is able to take nourishing liquids or soft solids by mouth. Since all needles are anchored in place by stitches, accidental displacement during this period is not a problem. If the tumor and its extensions interfere with swallowing, a small polyethylene catheter is introduced through the nose, past the lesion, and into the stomach, so that nutrition, maintained by a constant milk drip, can be started before definitive therapy is begun. Such a tube is well tolerated and can be used by the patient following discharge, for a

month or more if necessary. Although in the present series tracheotomy was not found to be necessary prior to therapy, it can be used as a life-saving procedure if the airway becomes embarrassed.

ANALYSIS OF RESULTS

In the series reported here, 35 of the 40 lesions were established by biopsy as squamous-cell carcinoma, usually of medium grade. Four of the 5 patients in whom biopsy was not obtained died before the end of five years, and 3 of the deaths were definitely due to cancer. Fifteen patients lived over five years and were free of cancer for that period, representing a survival rate of 38 per cent (Table I). The absolute survival rate for all 120 tongue cancer cases during this same period of observation was roughly the same, at 33 per cent. A total of 22 patients in this series presented clinical node metastases either at the first admission or subsequent to treatment of the primary lesion. As would be expected, the salvage in this group fell to 23 per cent (5 out of 22) as compared to 56 per cent (10 out of 18) in the absence of cervical metastases. Of the 4 patients with bilateral node involvement, none survived. Seventeen of the deaths are definitely classed as

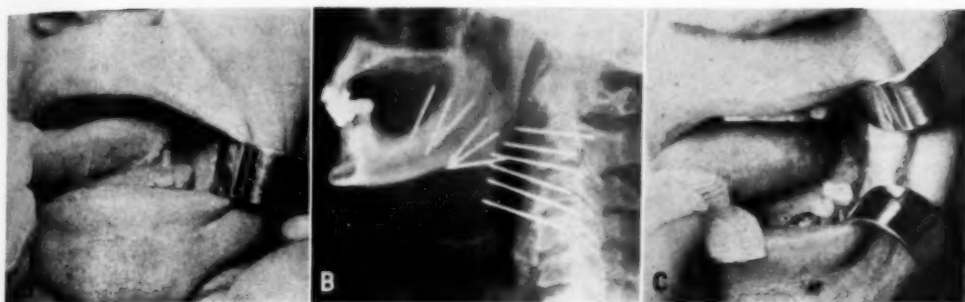


Fig. 4. A. Photograph showing anterior edge of a deep-seated carcinoma of the posterolateral tongue. B. Roentgenogram showing the needle pattern in the tongue and also beneath a metastatic node in the upper left neck. C. Complete primary healing two months later.

cancer deaths while there were 8 due to other causes before the end of the five-year period. The needle method was successful in producing healing of the primary lesion, usually within the first six to eight weeks, in over half of the patients treated.

COMPLICATIONS

It is significant that the complications of treatment in this series are considered, with one exception, to be relatively minor. There was only one instance of mandibular osteonecrosis and fistula formation, detected following extraction of teeth almost two years after therapy and eventually requiring partial mandibular resection. The patient recovered, however, and was well when last seen eight years after treatment of the tongue lesion. In the early years, it was customary to add prophylactic irradiation to the node drainage areas during treatment of the tongue carcinoma, and it is in such cases that mandibular necrosis has occurred. Since discontinuance of this practice, and with careful avoidance of overlapping treatment techniques in the region of the mandible, even when nodes are present, we feel that the incidence of such complications has been all but eliminated without obvious deterioration of survival rates. Teeth are not routinely disturbed prior to treatment unless poor dental hygiene dictates extraction or their position interferes with the approximation of adequate radium needle patterns to the tumor. In 10 instances, there were complications in the form of

small areas of ischemic necrosis in the tongue (4 cases), pain in the tongue scar following healing (2 cases), and areas of ischemic necrosis in the skin of the neck following irradiation of lymph nodes (4 cases). Where correction of these defects could not be accomplished with conservative handling, local resections and grafting, when necessary, have been followed by prompt healing. It is of interest that 8 of the 11 patients having complications have survived five or more years without disease.

DISCUSSION

The survival rates reported by other authors for carcinoma of the posterior tongue are generally lower than those for lesions involving the anterior tongue. This appears to be true for all methods of therapeutic approach. Although our series is small, the absolute salvage of roughly one in three compares favorably with results obtained in other tongue areas and indicates that the low-intensity radium needle technic offers certain advantages (Table II).

Satisfactory evaluation of treatment methods requires analysis of the factors affecting prognosis and study of the failures. In this series, syphilis was found to have no prognostic significance, nor was there any recognizable difference in survival or resistance between the sexes, although recent British studies have indicated a more favorable outlook in women (10). It is a fact that the extent of the primary lesion beyond the tongue is of

TABLE II: CARCINOMA OF THE POSTERIOR TONGUE:
REPORTED CURE RATES

| | Total Cases | Five-Year Survivals (%) |
|---|----------------|-------------------------------|
| Juliette Baud (Curie Foundation) | 331 | 10 |
| Elis Berven (Radiumhemmet) | .. | 12 |
| Sir Stanford Cade (Westminster Hospital) | 89 | 17.9 |
| B. W. Windeyer (Myerstein Insti- tute of Radiotherapy) | 81 | 9.8 |
| Constance Wood (Hammersmith Hospital) | 78 | 18.0 |
| H. B. Elkins (State University of Iowa) | 47 | 23.4 |
| Martin and Martin | 40 | 38 |

definite importance, and most clinics place lesions with extension into the tonsillar fossa, tonsillar pillars, or posterolateral floor of the mouth in a definitely poorer prognostic category than localized lesions. With the use of low-intensity radium needles, this feature would appear to be compensated and, indeed, no significant difference in survival between patients with localized tumors and those with such extensions was observed (Table III).

TABLE III: CARCINOMA OF THE POSTERIOR TONGUE:
EFFECT OF EXTENSION ON SURVIVAL

| | Num- ber | Five-Year Survivals |
|--|-------------|------------------------|
| Localized in tongue | 23 | 8 (35%) |
| Extension to floor, pharynx or epi- glottis | 17 | 7 (41%) |

The true failures—17 cancer deaths—resulted from inability to control the tongue and neck disease in 13 instances and the appearance of disseminated hematogenous metastases in 4 cases, the latter including 2 cases of pulmonary metastases and 1 of widespread bone involvement. The local recurrence rate was low, and failure to control the primary tumor was usually the result of uncontrolled tumor extension low in the pharynx or deep into contiguous tissues. There were no tumors which could actually be classed as radio-resistant, although there were variations in degree of responsiveness and rates of regression.

In this series, there are two factors which can definitely be incriminated as indicating a poor prognostic outlook, namely, delay in seeking treatment and the presence of

lymph-node metastases. A definite drop in survival rates accompanied increasing delay between the appearance of symptoms and treatment. This is as would be expected. A delay of six months or more spelled a significant drop in salvage, and the best results were obtained in those patients with symptoms for three months or less. A total of 22 patients, or roughly half the series, received treatment for lymph-node metastases. This incidence of node involvement is generally lower, however, than in many reported series, some of which record this occurrence in as many as 92 per cent (11), often with a high percentage of bilateral dissemination. This would indicate a fairly high incidence of early diagnoses in the present series and by the same token reflects definite credit upon the diagnostic acumen of the men in our locality who have referred the patients for treatment. Again, the importance of the laryngeal mirror and the palpating index finger is emphasized if one is to hope for improvement in the control of posterior tongue lesions. The low incidence of irradiation sequelae, such as dryness of the mouth and damage to the teeth, favor the localized cancerocidal dose by needle implantation over the irradiation of larger volumes of tissue by external sources.

SUMMARY

In a group of 40 cases of cancer of the posterior third of the tongue treated primarily by irradiation, a five-year salvage of 38 per cent was obtained. The primary lesions were implanted with low-intensity radium needles while neck nodes were managed by a combination of radium-needle implantation and x-ray therapy. Secondary surgery was used for removal of sequelae in a few cases. No block dissections were done. The results obtained compare favorably with a salvage of 33 per cent obtained for a group of 120 cancers involving all portions of the tongue treated with a similar technic.

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SUMARIO

Carcinoma de la Porción Posterior de la Lengua Tratado con la Irradiación

En un grupo de 10 casos de cáncer del tercio posterior de la lengua, tratados primariamente con la irradiación, se obtuvieron 38 por ciento de salvaciones de cinco años. En las lesiones primarias se implantaron agujas de radio de poca intensidad, en tanto que los ganglios cervicales fueron atendidos con una combinación de implante de agujas de radio y de roentgenoterapia. Se usó la cirugía secundaria para eliminar secuelas en algunos casos. No se hicieron disecciones en bloque. Los resultados obtenidos se comparan favorablemente con el 33 por ciento de curaciones conseguidas en un grupo de

120 cánceres que afectaban todas las porciones de la lengua y fueron tratados con una técnica semejante.

Los dos principales factores que contribuyeron a un pronóstico malo fueron la tardanza en el tratamiento y la existencia de invasión de los ganglios linfáticos. En esta serie, la sífilis careció de importancia pronóstica. Los resultados no favorecieron a un sexo más que al otro, y la difusión del cáncer a la fosa amigdalina, los pilares de las amígdalas o la porción posterolateral del suelo de la boca fué aparentemente contrapesada por las ventajas del implante de radio.

The Treatment of Lung Cancer with Radiation and Radiomimetic Drugs¹

DAVID I. LOCHMAN, M.D., and ROGER S. MORRIS, M.D.

THE ENCOURAGING results obtained by Roswit and his associates (4) by combining roentgen irradiation with nitrogen mustard in the treatment of pulmonary carcinoma prompted the writers to undertake this form of therapy between 1950 and 1954. Although the response of pulmonary carcinoma to nitrogen mustard is limited, it is sufficient to suggest that if it

or the irradiation could be spread over a much longer period of time. None of these seemed desirable, so that in our later patients, the x-ray therapy was given first, followed at once by nitrogen mustard while the tissues were undergoing their fullest radiation reaction. The lower systemic toxicity which could be expected seemed an advantage and Klopp's work (3) indicated

TABLE I: AVERAGE SURVIVAL FROM ONSET OF SYMPTOMS AND AVERAGE DURATION OF PALLIATION

| Dose Range | All Patients | | | X-Ray Therapy Only | | | Combined Therapy | | |
|-----------------|--------------------|--------------------------|---------------------------------|--------------------|--------------------------|---------------------------------|--------------------|--------------------------|---------------------------------|
| | Number of Patients | Survival Period (months) | Duration of Palliation (months) | Number of Patients | Survival Period (months) | Duration of Palliation (months) | Number of Patients | Survival Period (months) | Duration of Palliation (months) |
| Over 4,000 rDn | 15 | 12.5 | 5.1 | 6 | 12.1 | 1.7 | 9 | 12.7 | 7.4 |
| Below 4,000 rDn | 23 | 15.2 | 4.4 | 12 | 18.1 | 6.2 | 11 | 12.0 | 2.3 |
| All levels | 38 | 14.1 | 4.7 | 18 | 16.2 | 4.7 | 20 | 12.3 | 4.7 |

were combined with radiation better palliation might then be achieved. Results from irradiation alone are only fair. With the addition of nitrogen mustard, an increase in mean survival from 9.4 months to 12.8 months from onset of symptoms has been reported.

In experiments on mice, Karnofsky *et al.* (2) found that the toxicity of mustard, as measured by its lethal effect, was reduced by preliminary irradiation. In view of this apparent decrease in the effectiveness of the drug, it was decided to give the irradiation following rather than preceding the administration of the mustard, a procedure which had also been tried by others. It gradually became apparent, however, that the magnitude of the systemic reaction, particularly the hemocytic depression, limited the amount of radiation which could be given. Several ways of avoiding this were possible: The dose of mustard could be reduced, there could be a delay between the administration of mustard and irradiation to allow recovery,

that there would be no impairment of effectiveness of the mustard.

MATERIAL AND METHODS

Our pulmonary cancer series numbered 38 patients, 32 males and 6 females, and included 20 squamous-cell, 8 undifferentiated, and 3 anaplastic carcinomas and 2 adenocarcinomas. The diagnosis in the remaining 5 was based on the finding of neoplastic cells in sputum. In all except 12 obviously inoperable patients exploratory thoracotomy was done, with partial resection of the tumor (19 cases) or pneumonectomy (7 cases). Patients with evidence of generalized carcinoma were not accepted for treatment. No patient with a recorded white blood count under 5,000 received chemotherapy.

The radiation was given at 250 kvp, h.v.l. 1.5 mm. Cu, and focal-skin distance 50 cm. The treatment was directed to both the primary tumor and the mediastinum. A tissue dose rate of about 1,000 r per week was maintained.

¹ From the Department of Radiology, University of Chicago, Chicago, Ill. Accepted for publication in May 1955.

Six patients received intravenous nitrogen mustard initially and 6 following irradiation. The dose was 0.2 mg. per kilogram of body weight on each of four successive nights. Because of ease of administration and decreased side effects, an oral mustard-like preparation, triethylene melamine (TEM), and an intramuscular preparation, triethylene phosphoramide (TEPA), were also used. In all patients

TABLE II: RADIOGRAPHIC EVIDENCE OF TUMOR REGRESSION

| Dose Range | Number of Patients | Percentage Showing Tumor Regression | | |
|-----------------|--------------------|-------------------------------------|------------|------------------|
| | | All Treat- | X-Ray Only | Combined Therapy |
| Over 4,000 rDn | 15 | 80 | 33 | 78 |
| Under 4,000 rDn | 23 | 39 | 42 | 33 |

given oral chemotherapy, the drug was administered before irradiation. Six patients received an average of 20 mg. TEM in three days; 2 were given 10 mg. TEPA daily for seventeen days, at the beginning of the course of radiation. Where chemotherapy was given first, irradiation followed within the week. Eighteen patients received radiation alone. X-ray films of the chest were made at the beginning and at the termination of treatment and at intervals thereafter.

DISCUSSION

From experience with other neoplasms, it is reasonable to assume that doses below 4,000 rDn in four weeks are normally only palliative. To assess the value of higher doses, the patients were separated into those receiving an estimated tumor dose above 4,000 r and those receiving less than this amount. Palliation was not considered achieved unless the patient was ambulatory, able to take care of himself at home, and free of pain. The average survival periods and duration of palliation are shown in Table I. Neither was increased by the higher dose of radiation nor the addition of chemotherapy.

While the patients who received higher doses showed greater tumor regression as

TABLE III: COMPARISON OF SEQUENCE IN COMBINED THERAPY

| Sequence | Number of Patients | Survival from Onset of Symptoms | Duration of Palliation |
|----------------------|--------------------|---------------------------------|------------------------|
| Initial chemotherapy | 14 | 12.8 months | 4.3 months |
| Initial radiotherapy | 6 | 11.0 months | 5.4 months |

demonstrated on chest films (Table II), their clinical response was no better than that of the others. The sequence in which radiation and mustard were given had no effect on the results (Table III). Patients who had experienced symptoms longest before treatment generally received lower doses of radiation. In these palliation seemed to be of the longest duration, which would indicate that the natural history of the disease exerts more influence on survival time than any other factor.

CONCLUSIONS

1. The clinical results produced by a combination of chemotherapy and irradiation in primary lung cancer are not superior to those obtained with irradiation alone, though chemotherapy in combination with high-dose irradiation is followed by greater objective evidence of tumor destruction.

2. Irradiation alone gives substantial symptomatic relief, but high dosage does not increase survival time over moderate dosage.

3. The sequence in which chemotherapy and radiation are given does not affect the clinical result.

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SUMARIO

El Tratamiento del Cáncer Pulmonar con la Irradiación y las Drogas Radiomiméticas

Preséntase una serie de 38 carcinomas del pulmón, 18 de los cuales fueron tratados con la irradiación roentgen sola, 12 con la irradiación ya precedida o seguida de la administración endovenosa de mostaza nitrogenada, 5 con melamina trietilénica (MTE) oralmente seguida de la irradiación y 2 con la inyección intramuscular de fosforamida trietilénica precediendo a la irradiación. Los resultados clínicos en los enfermos que recibieron quimioterapia ade-

más de la irradiación no fueron superiores a los de la irradiación sola, aunque con la terapéutica combinada se observaron mayores pruebas objetivas de destrucción del tumor.

La irradiación sola logró importante alivio sintomático. Dosis mayores no acrecentaron el tiempo de sobrevivencia. El orden en que se administraron la quimioterapia y la irradiación no afectó el resultado clínico.



Current Techniques in the Handling and Distribution of Cobalt 60 Radiation Sources¹

A. B. LILLIE, Ph.D.

ONE OF THE MOST important early uses of gamma-ray sources was in radium therapy. With the advent of nuclear reactors and pile-produced isotopes it became quickly apparent that a major step in radiation treatment could be made by replacing radium with much more intense sources, artificially produced. It is not surprising that some general techniques of production and handling should develop around the special requirements of the first of these high-intensity multicurie sources.

The characteristics of a source suitable for radiation therapy are high intensity, small size, reasonably long half-life, and sufficiently high-energy gamma-ray emission (1). Of the various gamma-ray emitters which can be produced in a reactor, cobalt 60, with gamma-ray energies of 1.17 and 1.33 MEV, has appeared to be most suitable and has been most used.

The high intensity required for a therapy source together with the need of a small geometrical size suggest the use of material of high specific activity. High intensity allows treatment from a distance great enough for good depth-dose characteristics and small size results in a desirably small penumbra. Specific activity is proportional to the neutron activation cross section and to the neutron flux. For cobalt, this cross section is relatively large, 34 barns, but the maximum specific activity is still limited by the neutron flux available. Not until high-flux reactors such as Canada's heavy-water reactor, NRX, began operating was it possible to produce the high specific activity, and therefore the high-intensity sources, suitable for radiotherapy. With NRX, for example, in a standard production position, specific activities of 35 curies per gram may be pro-

duced in less than eighteen months. With this specific activity, a source containing approximately 2,000 curies of cobalt 60 can be made which will deliver a dose of 50 r per minute in air at a treatment distance of 80 cm.

The absorption of neutrons in the target material—cobalt metal in this instance—produces other effects which must be taken into account. In a reactor, a mass of neutron-absorbing material will lower the neutron flux in the vicinity; in addition, the outer layers of the mass will shield the inner layers from the neutrons. Each of these two phenomena, "flux depression" and "self-shielding," will lower the effective neutron flux and thus the specific activity produced (1). In the production of cobalt 60 in large quantities in NRX, it is estimated that the specific activity is lowered by 50 per cent, due primarily to flux depression.

To reduce self-shielding, the Canadian approach has been to use the cobalt in the form of small cylindrical pellets 1.0 mm. in diameter by 1.0 mm. long. These pellets can be held during neutron irradiation in thin (approximately 3 mm.) cylindrical shells and then, after removal from the reactor, be transferred into a source container suitable for use in therapy machines. In this container, the pellets form a right circular cylinder of 3 cm. maximum diameter and 3 cm. maximum length. This versatility of form can take advantage of the best geometry for pile irradiation as well as the best geometry for therapy. One disadvantage of using a cobalt pellet source is that the bulk density of the pellets (4.8 gm./c.c.) is approximately one-half that of solid cobalt (8.9 gm./c.c.) and, as a result, fewer curies of activity can be contained within a given volume.

¹ From the Commercial Products Division, Atomic Energy of Canada Limited, Ottawa, Ontario, Canada. Presented at the Forty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 11-16, 1955.

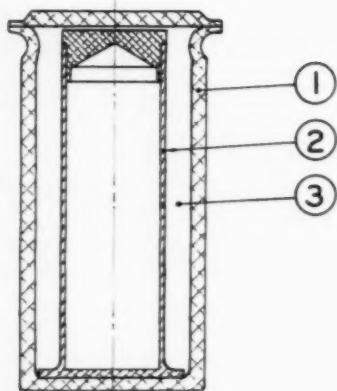


Fig. 1. Aluminum irradiation capsule in which cobalt pellets are irradiated. 1. Irradiation capsule. 2. Liner. 3. Annular shell.

Since cobalt 60 has a half-life of only 5.3 years, corrections for decay must be made periodically. Eventually, probably within one half-life, the intensity of the source will have decreased to the point where replacement is necessary. Even the decayed source does represent, however, a considerable neutron-irradiation time and cannot be lightly discarded. One possibility is for the source to be used where lower intensity is adequate. Another possibility, one adopted by Atomic Energy of Canada Limited (the Canadian supplier of radioactive isotopes), is for this active material to be returned to the supplier for reactivation. This choice is based on economic factors rather than technical aspects.

PROCEDURE AND EQUIPMENT

Upon the foregoing general considerations are based the steps involved in manufacturing and delivering a therapy source. These steps are:

1. Loading of inactive or active cobalt pellets into irradiation capsules.
2. Loading of irradiation capsules into irradiation rods, and the rods into the reactor.
3. Neutron irradiation of the cobalt in the reactor.
4. Removal of the cobalt from the re-

actor to the source preparation facilities.

5. Source preparation.
6. Shipping of the source.
7. Loading of the cobalt source into the facilities where it is to be used.

The loading of inactive cobalt (in Step 1), which is a straightforward operation, will

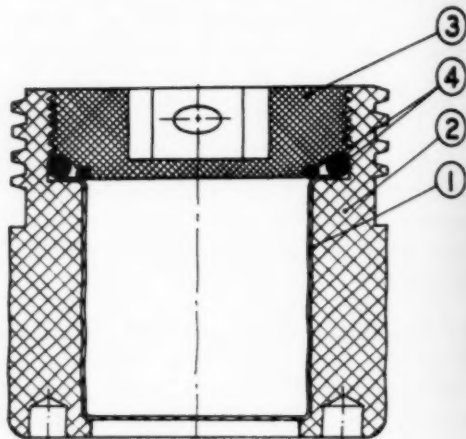


Fig. 2. Therapy source container. 1. Cup. 2. Body. 3. Plug. 4. Gaskets.

not be considered here; Step 3, the neutron irradiation, is beyond the scope of this paper.

All remaining steps involve the transfer of radioactive material. In Steps 1 and 5 this material is in the open while being transferred from one container to another, but in Steps 2, 4, 6, and 7, it is inside sealed containers.

Steps 1 and 5: Since Steps 1 and 5 are concerned with the transfer of active material from one sealed container to another, it will be helpful to describe these containers. Figure 1 (Item 1) shows the irradiation capsule, *i.e.*, the sealed container which holds the cobalt while the latter is irradiated. It is a circular cylinder approximately 19 mm. in diameter by 4.5 cm. long, made of 1-S (high purity) aluminum, with a flange on one end and closed on the other end. To this flange an aluminum disk or lid is sealed by cold welding (700 kg. per square centimeter is required). In order that the cobalt pel-



Fig. 3. Hot cell in which therapy sources are prepared.

lets may shield each other as little as possible from the neutron flux, as discussed above, a closed aluminum tube or liner (Fig. 1, Item 2), 12.5 mm. in diameter by 44 mm. long, is inserted in the capsule to form an annular shell (Fig. 1, Item 3) into which 30 gm. of the pellets are loaded.

In Figure 2 is shown a therapy source container, the design of which was developed and adopted as a standard by manufacturers of therapy equipment and by the source producers of the United States of America and Canada (2). A thin (0.5-mm.) stainless steel cup (Fig. 2, Item 1) which fits in the tungsten alloy body (Fig. 2, Item 2) holds the radioactive material but permits the gamma radiation to pass through the end with only a 2 per cent attenuation. A tungsten alloy plug (Fig. 2, Item 3) holds the source and steel

cup in position, sealed by two lead wire gaskets (Fig. 2, Item 4) to prevent the escape of any dust. The outer size and shape of this container have been standardized to allow its use in different designs of therapy machines, but the internal size may be altered by a change of plug to accommodate cobalt pellets, cylinders or disks, or for use with the various specific activity materials available. For small diameter sources, tungsten sleeves can be inserted to reduce the cavity size.

The source preparation facilities have thus been designed for the loading and the unloading of these two containers, although other containers of similar size and shape can be handled. These facilities—the hot cell—require, first, equipment to prevent exposure or contamination of operating personnel and, second, equipment

to load and seal or to open and empty irradiation capsules and therapy source containers.

The first of these two requirements is concerned primarily with shielding. The hot cell shown in Figure 3 is a cavity 84 cm. wide by 65 cm. high by 56 cm. deep,

vacuum system which maintains a negative pressure within the cell ensuring that no radioactive dust, if produced, could find its way out. The three intakes of the vacuum system are arranged near those points of operation where dusting could occur, and the exhaust of the system is

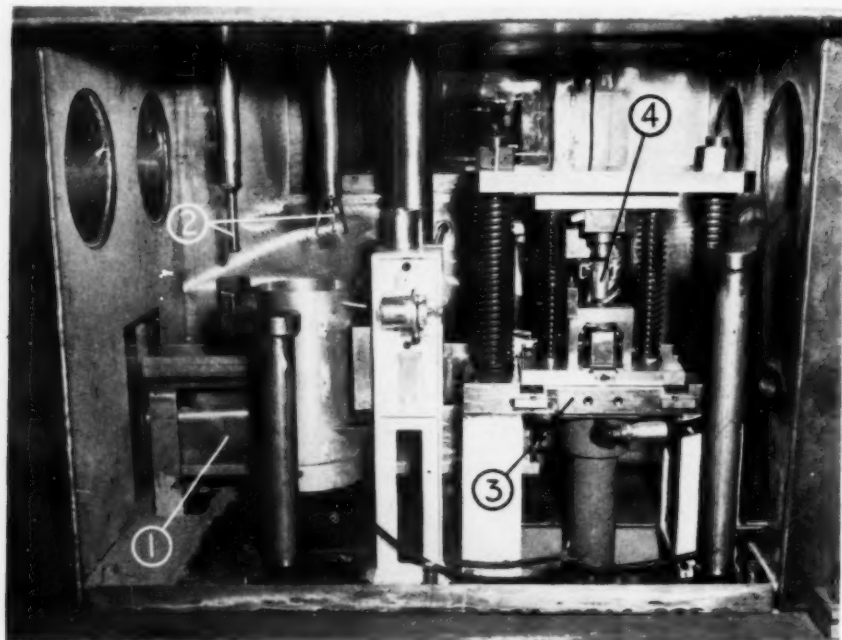


Fig. 4. Interior of hot cell during construction: view from rear. 1. Entry drawerway. 2. Tongs. 3. Hydraulic press. 4. Capsule being placed in press.

surrounded by poured lead encased in steel. A front window 25 cm. wide by 16.5 cm. high, made of a high-density glass (density of 6.2 gm./c.c.), is provided for viewing all operations. This window consists of four plates of the high-density glass, each 10 cm. thick, and an innermost plate, of a darkening-resistant cerium glass, 5 cm. thick. The amount of shielding used, 30 cm. of lead on the front wall and 25 cm. of lead elsewhere, will allow cobalt sources of several thousand curies to be prepared without raising the external field above the working health tolerance (7.5 mr/hr.). Operators of the hot cell can thus work normal hours without undue exposure. Also required for safety is a

passed through a filter² before being released to the atmosphere. Due to the very high specific activity involved, even the slightest amount of dust escaping from the cell could produce a serious contamination problem. Even though the shielding is greater than actually required for most of the sources prepared, film badges and pocket dosimeters are worn by the operators and a health surveyor is on hand to monitor the radiation field. This monitoring is particularly important as a safeguard during transfers of sealed containers from one shielded case to another, as shown in Figure 3.

² Absolute filter made by the Cambridge Filter Corporation, Syracuse, N. Y.

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The second part of the equipment required for the hot cell is chiefly that used for actually handling the active material in irradiation capsule operations, therapy source container operations, or both. First, all tools and accessories are mounted on stepped plugs in the walls or ceiling and are

with reference to Figures 4 and 5, which show the hot cell from the rear and top, respectively, at different stages of construction. The sealed container of source material which is brought to the hot cell in a transfer-case drawer is moved into the cell as indicated in Figure 3. The entry

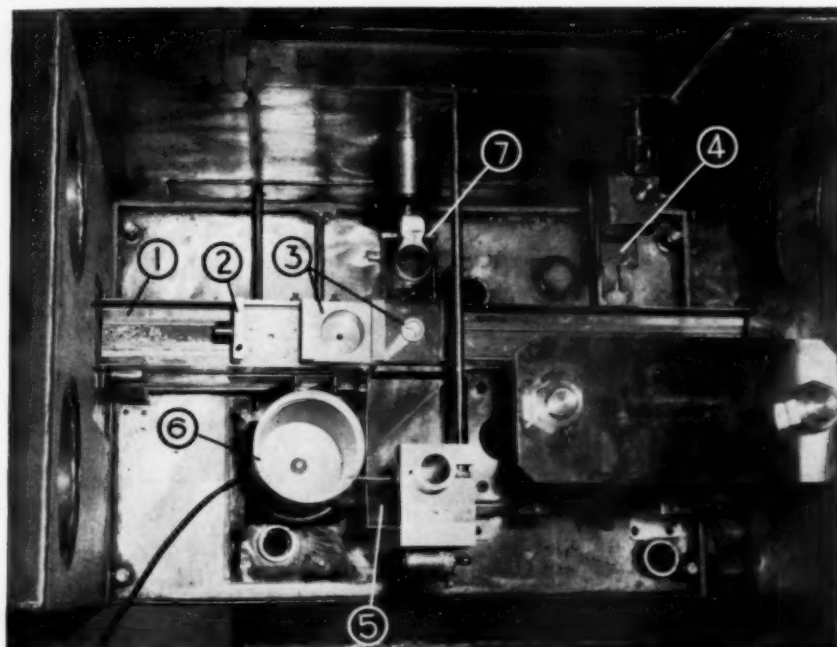


Fig. 5. Interior of hot cell during construction; view from top: 1. Slide. 2. Tray. 3. Inserts. 4. Tongs. 5. Pellet reservoir. 6. Vibrating spiral conveyor. 7. Loading tongs.

removable for cleaning, repair, or exchange. This last allows a greater flexibility in the operations which can be performed in a cell of this size. Where possible, all tools are arranged with pre-set stops to facilitate the operations. All the movements within the cell are mechanically operated through the shield by hand, except for a press and a conveyor which are operated hydraulically and electrically, respectively. If necessary, the cell can be cleaned of pellets or active dust through the ports made by removing stepped plugs. The interior surface is stainless steel with the joints filled with a metallic filler to permit easier cleaning.

The operations can best be described

drawerway is Item 1 in Figure 4. Directly above it is another slide on which a tray carrying three inserts can be moved completely across the cell or to the outside. The slide and the tray with two inserts in place are best seen in Figure 5 (Items 1, 2, and 3). This tray with the appropriate inserts can carry irradiation capsules or source containers. Two vertical tongs (Fig. 4, Item 2) are mounted 180° apart on a plug in the ceiling. By rotation of the plug either of the tongs can be located directly above the drawerway and slide and can lift the container from drawer to tray insert or *vice versa*. The tray carries the container of active material to one of two positions. At one position, used pri-

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marily with irradiation capsules, is the hydraulically-operated press (Fig. 4, Item 3). The press, removable through a port to the outside of the cell, can be used either for cold-weld sealing of the loaded irradiation capsules or for shearing off the capsule lids for unloading, merely by changing inserts. The tongs at the press position (Fig. 5, Item 4) have longitudinal and vertical movements. In Figure 4 (Item

pellets. It has been found necessary to outgas the pellets before loading, because of the internal pressures which are otherwise built up in the capsule during irradiation, causing excessive bulging (3). This outgassing is accomplished by heating the pellets for approximately four hours in a muffle furnace at 300° C., then cooling to room temperature under a vacuum, and finally storing in a closed vessel until used.

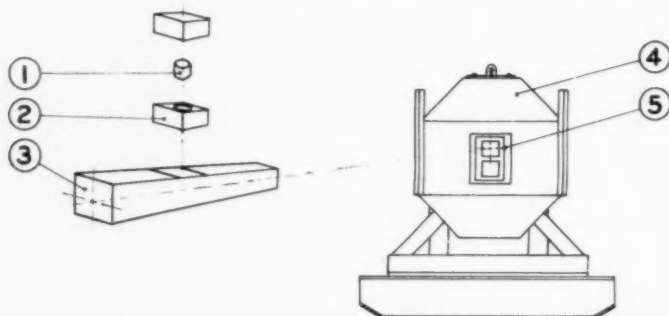


Fig. 6. Two-drawer transfer case and interior components.

4), an irradiation capsule has been placed in the tongs to indicate the capsule position just as it is put into the press. At the other operating position is a reservoir for the cobalt pellets from which, by a vibrating spiral conveyor, the pellets can be fed with a fine control into the final container—either therapy source container or irradiation capsule (Fig. 5, Items 5 and 6). At this loading station the tongs (Fig. 5, Item 7) have longitudinal and rotary movements.

A square end wrench through the ceiling can be inserted in a socket in the plug of the therapy source container to unscrew, lift, and hold the plug during loading and subsequently to replace it.

A simple spring balance made to hold an irradiation capsule, and used for weighing out the amount of cobalt, can also be placed in the cell through a port. This device, for convenience, is normally pre-set so that the desired amount of cobalt causes it to balance at the index.

Two other operations which have been used in loading inactive pellets are being incorporated into the loading of active

Also, in order that the cobalt, which is at a high temperature during the irradiation, will not oxidize, the capsules are sealed under one-half atmosphere of helium.

Illumination of the interior of the hot cell is provided by four 150-watt incandescent lamps, also mounted on stepped plugs—two in the ceiling and two in the walls. Since most glass will darken under intense gamma radiation, viewing of the operations will not be possible unless suitable precautions are observed. Thus, besides making the innermost layer of the window of a darkening-resistant glass, it has been found desirable to avoid storing active material in the cell except when it is actually being used. In addition, the lamps are left on at all times when source material is in the hot cell, so that the heat will keep the glass bulbs relatively free of darkening.

Steps 2, 4, 6, and 7: The transfer of active material, whether sealed in irradiation capsule or in final source container, is based on the use of a sliding lead drawer (Fig. 6, Item 3) and a lead-shielded case. The source, in a lead or tungsten alloy

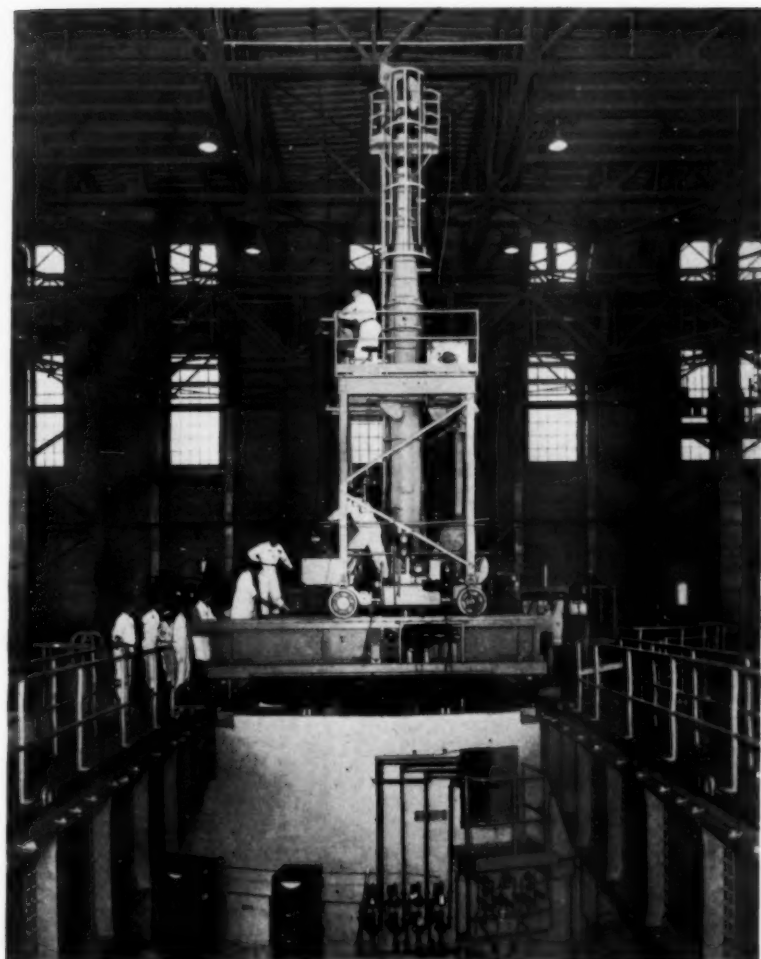


Fig. 7. Twenty-five-ton lead flask used in unloading irradiation rods from reactor.

insert (Fig. 6, Items 1 and 2), is placed in a cavity in the center of the lead drawer and, in subsequent transfers, the drawer and the source move as a unit. This drawer provides a major part of the primary shielding of the lead-shielded transfer case or therapy unit in which it is placed. While there are several lead-shielded cases, varying in exterior size and shape, depending on their uses, the drawer holes are standardized, as is the drawer cross section (3×3 in. or 7.62 cm. square); this allows the drawers to be moved freely and safely from one container to any other container.

To move or to ship a source from one location to another thus involves (a) sliding the source-plus-drawer unit from its original housing into a transfer case, (b) moving this case to the new location, and (c) sliding the source-plus-drawer unit from the transfer case into the new facility or container. During the operation, when the drawer is moved from one container into another, the two containers are lined up next to each other so that personnel exposure is negligible.

To remove the cobalt from the reactor and take it to the source-preparation hot

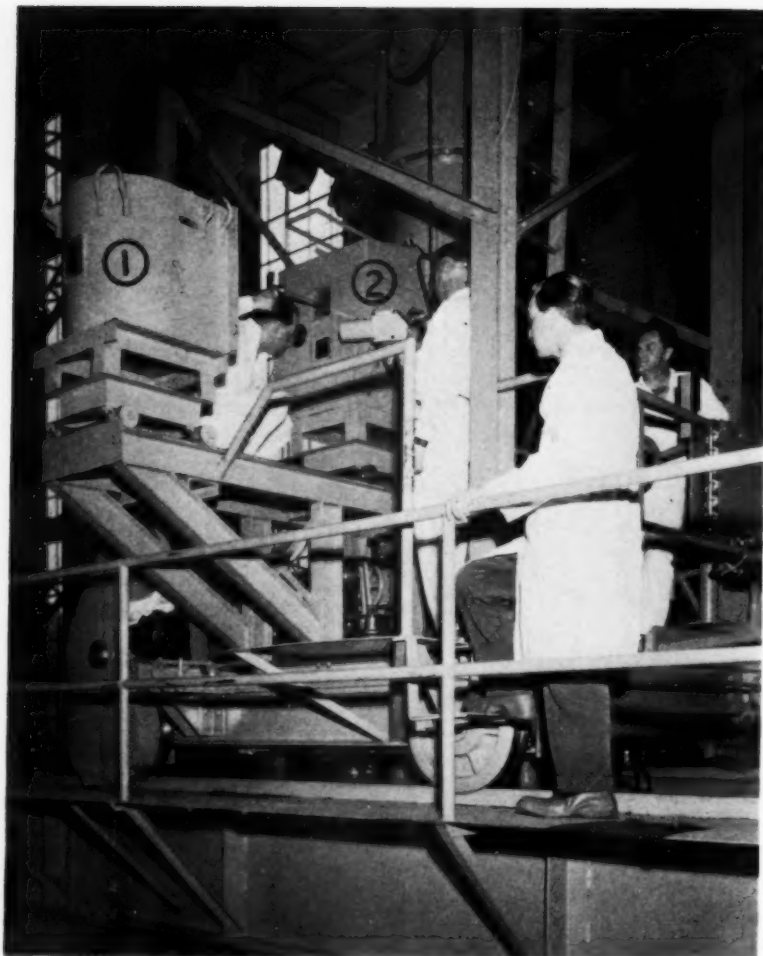


Fig. 8. Unloading irradiation capsules from irradiation rods.

cell, two lead-shielded cases are used. The irradiation rod in which the capsules of cobalt are placed in the reactor is withdrawn into the first shielded case, a tall 25-ton steel-encased lead cylinder shown over the reactor in Figure 7. On the side of this case is a shield (Fig. 8, Item 2) into which a drawer slides and through which tongs move. The capsules are then removed with the tongs and dropped into the holes in the drawer, two capsules per drawer, as demonstrated in Figure 8. The drawer is then slid into the second transfer case (Fig. 8, Item 1), which is used to take the

active material to the source preparation cell. To reload active material into the reactor, these operations are reversed.

A two-drawer transfer case (4) in which therapy sources are normally shipped is shown in Figure 6 (Item 4) and can be seen in the foreground of Figure 3. The total weight of this steel-enclosed lead container is about 1,800 kg. and the 25 cm. of lead provides sufficient shielding so that with 10,000 curies of cobalt in the case, the radiation field is approximately 10 mr/hr. at 1.0 meter. This shielding is adequate to meet shipping regulations, for rail, boat,

or truck in most countries. For shipping, of course, all necessary safeguards such as end plates bolted over the drawer holes, asbestos gaskets, locks, labels, etc., are added.

When a source in a therapy unit is to be replaced, the new source is shipped in the transfer case to the unit. The drawer plus old source is drawn from the therapy unit into the transfer case and the new source and drawer is then moved from the transfer case into the therapy unit. An empty or dummy drawer is used to follow up the full drawer during each transfer to avoid leaving an opening through which a dangerous radiation beam could emerge.

To load these sources into shipping cases without the sliding drawer technique, special methods are used.

While the development of the above technique has been based on the production of therapy sources, other types of even higher curie content have been prepared by irradiating cobalt rods or cylinders individually and then assembling them into the larger sources. A description of two such sources will indicate how these can be treated.

In one source, the active material was in the form of 100 aluminum-jacketed cobalt cylinders, 6.3 mm. in diameter by 25 cm. in length. In the irradiation rods they were arranged in circles of 6 cylinders each. Following irradiation, the rods were removed from the reactor and placed in a water trench. Here with 3.5 meters of water providing sufficient protection, the rods were cut apart and the cobalt cylinders transferred with tongs into a cavity in a special shipping case which had been lowered into the trench. After the case was closed, it was lifted from the trench and any water in the cavity drained out through a special offset drain-hole. The total activity of the source was approximately 4,000 curies.

Another source about to be fabricated will consist of cobalt slugs 6.3 mm. in diameter by 2.5 cm. long, also aluminum-jacketed. These slugs too are arranged in

circles in the irradiation rods with 7 slugs per circle and will be unloaded in the water trench in the same way as was the source mentioned above. In this instance however, the slugs will be loaded within a lead shield into stainless steel tubes to form a "pencil" source of 9 slugs each. After the lead shield is raised just above the water level, a special heater will bake out any moisture and the pencil will be sealed by shrink fitting a plug into it. This pencil will then be dropped into a special shipping container under water as before. By this method, only a small fraction of the total activity need be handled at any one time. The total source strength in this case will be approximately 10,000 curies.

SUMMARY

Two approaches to handling high intensity radiation sources are described. First, for the so-called point sources (therapy type), a small cell, well shielded by lead and fitted with a few interchangeable tools, has been employed. The cell is limited primarily by the geometry of the containers of the activity. The operations are, on the other hand, easily viewed and relatively delicate manipulations can be carried out. Second, for those sources which are large or distributed, a water-filled trench has been used. The operations here are not as readily visible, and precision operations cannot be carried out. The shielding, however, is inexpensive, and the shielded volume can be large. In addition, by handling the activity a little at a time, it is sometimes possible to avoid altogether the problems of a very high-intensity source. For transferring or shipping sealed sources, the sliding drawer method is seen to be adaptable and, for this type of operation, easy to carry out.

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SUMARIO

Las Técnicas Corrientes en la Manipulación y Distribución de los Focos de Radiación de Cobalto 60

Descríbense aquí el procedimiento y el equipo usados en la manipulación y la distribución de los focos de radiación de cobalto 60.

Al irradiar cobalto, que posee una gran sección transversal de absorción de neutrones, hay que prestar atención al auto-resguardo del elemento, que amengua la radioactividad producida. Para reducir este efecto, el cobalto es irradiado en forma de bolitas dispuestas en capas delgadas. Esas bolitas tienen que ser cargadas después en un cilindro de poco volumen, 3.3 cm. de diámetro por 1.5 cm. de grueso, para formar el foco. El poco volumen es conveniente a fin de poder aproximarse a las características de un foco en punto.

Se ha elaborado un equipo especial de manipulación que permite introducir bolitas ya inactivas o activas en cápsulas de irradiación, extraer las bolitas radioactivas de cobalto de las cápsulas de irradiación e introducir las en recipientes especiales de focos para empleo en aparatos de radioterapia.

El éxito en el empleo de estos focos de

alta intensidad requiere una técnica de remisión, carga y descarga que reduzca al mínimo la exposición del personal. El foco sellado se coloca en forma permanente en una gaveta hecha de plomo u otra sustancia compacta. Esta gaveta es una parte componente del aparato definitivo en que se instala el foco y suministra una porción importante del resguardo primario de dicho aparato y de la caja usada para traslado. Esta caja es un recipiente de plomo envuelto en acero que suministra suficiente resguardo para cumplir los requisitos de embarque y de higiene.

Aunque la mayor parte de los focos de cobalto en milicuries toman forma de bolitas, se han preparado otros tipos. Un foco de 10,000 curies estaba compuesto de lingotes cilíndricos que requerían medios especiales de carga, recipientes especiales para traslado y técnicas especiales de manipulación. Estas se basaban en el uso de un surco de agua para resguardo primario. Estos probablemente se volverán más numerosos a medida que aumenten las aplicaciones comerciales.

DISCUSSION

Paul C. Aebersold, Ph.D. (Oak Ridge, Tenn.): The Canadians are to be congratulated on being able to produce so much cobalt 60. We in the United States are very happy about this because none of our reactors were built with isotopes production in mind. We get isotopes only as by-products of other operations. You will note it takes about 18 months to produce the type of cobalt most people want, with specific activity of over 30 curies per gram; also you have seen the heavily shielded equipment required to handle cobalt. You may thus understand why cobalt is, necessarily, expensive. It requires long bombardment and costly equipment.

Statements have been made that cobalt 60 might be produced very cheaply, at say less than one dollar per curie. This might be possible if the cobalt were obtained as a by-product in a very large reactor, at a rate of millions of curies per year. By producing megacurie quantities, the price could be brought down, but perhaps still not as low as a dollar per curie. With an output of a few hundred thousand curies per year, the price of high specific activity cobalt today represents approximately the production cost.

I should point out a difference in cobalt production between the United States and Canada. In Canada there are facilities for re-irradiating cobalt, that is

taking several thousand curies and putting it back in the reactor. We have no facilities in most of our reactors for loading very active samples; consequently, our philosophy has been not to re-irradiate cobalt but to develop a system for successive use of decaying sources. For example, we start with a 1,000- to 2,000-curie source in a large teletherapy unit and then, several years later, move it to a smaller so-called hectacurie unit. When the cobalt is too weak for use there, other uses will be found. We have not, however, worked out a radiocobalt brokerage system. Someone will no doubt develop a business of reselling cobalt after it decays below teletherapy range.

Another difference in the systems derives from the fact that if you are to re-irradiate cobalt you must have a system for taking the sources apart. The Canadians irradiate small round pellets which can easily be transferred back and forth into different radiation source containers. Because in our system we do not re-irradiate material, we use thin wafers which permit more compact sources. The wafers need to be stacked up only about a centimeter high. For the Canadian pellets, the source has a volume two times as large, so it must be higher or wider. But no matter what the form, we are presently short of cobalt 60 and are happy that Canadians make a lot of it.



Improvement of Osseous Changes in the Sella Turcica Following Irradiation for a Pituitary Tumor

A Case Report¹

HOWARD ADLER, M.D.,² and GUSTAVE KAPLAN, M.D.³

CHANGES IN THE size and structure of the sella turcica following roentgen therapy for a pituitary tumor have only rarely been observed. Pancoast, Pendergrass, and Schaeffer (6) have stated, "The bone in the dorsum sellae is seldom, if ever, regenerated after it has been destroyed by pressure. On the other hand, if the dorsum sellae is destroyed by an infiltrating growth, regeneration may occur, as is evidenced in a few instances on record."

Von Poswick (7) reports a case of recalcification of the sella turcica after roentgen therapy, but in this instance the sellar involvement was secondary to a malignant growth. Decrease in the size of the sella after irradiation in pituitary gigantism has been reported by Hurxthal (4), and 8 cases in which an enlarged sella diminished in size following roentgen therapy are cited by this same writer and his associates in another communication (5). All of this latter group were acromegalics; in 1 of the cases, the decrease was a result of operative procedure plus irradiation, with subsequent re-enlargement. Gray and Newell (3) have presented a case of diminution of the enlarged sella and amelioration of symptoms in a nineteen-year-old male with a pituitary tumor and hypopituitarism. Reossification of the sella turcica was reported by Dyke and Davidoff (2) in a young female who received radiotherapy for a chromophobe adenoma of the pituitary over a ten-year period.

In the case to be described here, irradiation of a pituitary tumor with an eight-year history of symptoms was followed by clinical improvement with concomitant osseous regeneration of the sella turcica.

CASE REPORT

A 46-year-old white male had symptoms dating back to 1945, during service in the Armed Forces. The chief complaints were numbness of the fingers; progressive enlargement of the head, jaw, hands, and feet; severe frontal headaches; impaired visual acuity and ptosis of the left upper eyelid; urinary frequency; weakness, cachexia, and somnolence. All of these symptoms were slowly progressive in nature over an eight-year period, up to the time of hospital admission May 19, 1953. The pertinent physical findings at that time were acromegalic changes involving the bones of the skull, face, hands, and feet; slight prominence of the left orbital contents; ptosis of the left upper eyelid; enlargement of the left pupil as compared with the right, without reaction to light; inability to turn the left eye laterally; marked weakness of left ocular movements; slight haziness of the disk borders, bilaterally; diminution of touch and pain sensation over the left side of the face; marked weakness and fatigue with minimal exertion.

The salient laboratory data included mild diabetes mellitus, which was controlled by diet; hypothyroidism, as evidenced by a twenty-four-hour uptake of radioactive iodine of 5 per cent and a basal metabolic rate of minus 5 per cent; normal findings on electroencephalography and lumbar puncture; generalized contraction of the visual fields for both eyes.

Roentgen examination of the *skull*, May 19, 1953, demonstrated prognathism, enlarged frontal sinuses, a prominent external occipital protuberance, enlargement of the sella turcica in the vertical dimension to 15 mm. and in the anteroposterior diameter to 21 mm. The normal range of sella measurements according to Camp (1) is 4 to 12 mm. in the vertical diameter and 5 to 16 mm. in the anteroposterior diameter. There was associated thinning of the dorsum sellae, posterior clinoids, and floor of the sella turcica.

Roentgenograms of the *hands*, June 1, disclosed marked thickening of the soft tissues, a spade-like appearance, prominent ungual tufts with bony protuberances on the shafts of the phalanges, and abnormally short metacarpals.

Chest films, taken May 19, were normal.

The most likely diagnosis was thought to be combined eosinophilic and chromophobe adenoma

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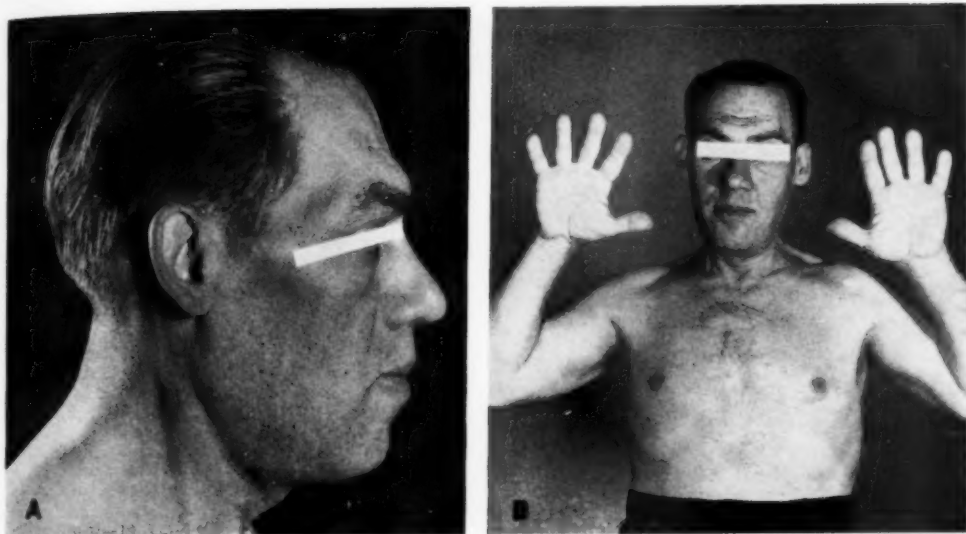


Fig. 1. A. Profile view demonstrating prognathism. B. Frontal view showing characteristically enlarged jaw and skull. Note the short fingers with marked overgrowth of soft tissue.

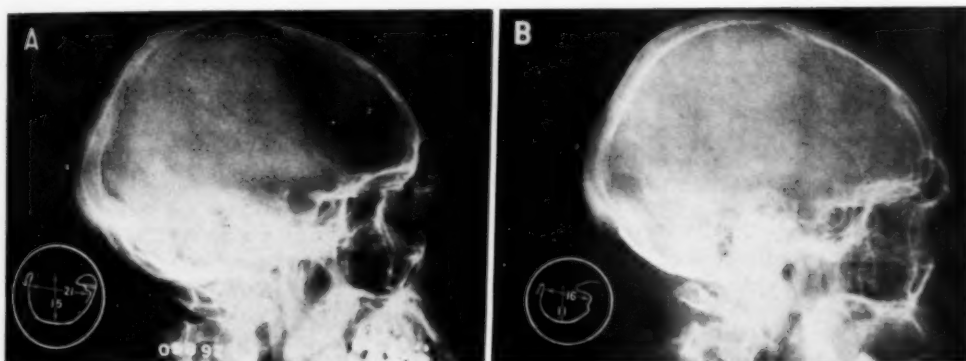


Fig. 2. A. Lateral view of skull, prior to irradiation, showing the ballooned sella turcica, enlarged frontal sinus, and prominent external occipital protuberance. Inset depicts actual tracing of sella contour and measurements from film previous to therapy.

B. Lateral skull film, postirradiation, demonstrating decrease in size of the sella turcica, with bone regeneration. Inset shows sella measurements as traced from film one and one-half years after therapy.

of the pituitary with a left superior orbital syndrome involving the left third, fourth, fifth, and sixth cranial nerves. The patient was referred to the Radiation Therapy Department, where complete rotation therapy was instituted. Factors were 260 kv, 18 ma., 0.5 mm. Cu filter, 1.3 mm. Cu h.v.l., and a target-axis distance of 85 cm. A tumor dose of 3,000 r was delivered to the sella turcica in a period of four weeks, through a field measuring 6 X 8 cm. Therapy was completed in June 1953.

Following treatment, the patient improved subjectively and objectively, with diminution of headaches and gain in visual acuity. General lassitude abated. Subsequent examination of the visual fields

revealed marked improvement bilaterally. Cranial nerve involvement gradually cleared and eventually completely disappeared. Mild degrees of diabetes and hypothyroidism persisted, the former controlled by diet, the latter by thyroid extract. A twenty-four-hour radioactive iodine study, performed two months after therapy, disclosed a 20 per cent uptake, as compared with the earlier figure of 5 per cent.

The patient was followed at monthly intervals over a period of one-and-one-half years and remained in good health. Roentgenograms of the skull on Nov. 2, 1954, disclosed a striking change in the appearance of the sella turcica. The vertical



Fig. 3. Roentgenogram of hands showing the spade-like deformity with prominent ungual tufts and soft-tissue overgrowth.

measurement was then 11 mm., compared with the previous figure of 15 mm. The anteroposterior diameter measured 16 mm., in contrast to the earlier measurement of 21 mm. In addition, the sellar floor, posterior clinoids, and dorsum sellae appeared thicker in structure. These findings were corroborated by spot-film examinations over the sella turcica as well as a mid-line tomographic study of the skull.

SUMMARY

An unusual example of improvement of osseous changes in the sella turcica follow-

ing radiotherapy for a pituitary tumor has been presented.

The diminution in the size of the sella turcica and the evidence of bone regeneration occurred after a tumor dose of 3,000 r delivered to a patient with acromegaly and clinical evidence of hypopituitarism.

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SUMARIO

Mejoría de las Alteraciones Oseas de la Silla Turca Consecutivamente a la Irradiación por Tumor Hipofisario: Presentación de un Caso

Comunicase un caso extraño de mejoría de las alteraciones óseas de la silla turca a continuación de la radioterapia administrada por tumor hipofisario. Las radiografías del cráneo y de las manos y las observaciones clínicas condujeron al diagnóstico de adenoma eosinófilo y cromóforo combinado de la hipófisis. La fosa hipofisaria estaba agrandada, unido esto a adelgazamiento del suelo, así como del dorso de la silla y de las clinoides posteriores.

La reducción del tamaño de la silla turca y los signos de regeneración ósea aparecieron después de entregarse una dosis tumor de 3,000 r a la zona durante un período de cuatro semanas a través de un campo que medía 6×8 cm. Los factores terapéuticos comprendieron 260 kv, filtro de 0.5 mm. de Cu, capa de h.r. 1.3 mm. Cu, 18 ma y distancia foco-eje de 85 cm. Se utilizó la rototerapia total.

The Linear Electron Accelerator as a Source of Fast Electrons for Cancer Therapy¹

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IN THE QUEST FOR improvement of radiation therapy of malignant tumors the utilization of fast electrons has appeared to us particularly attractive (1). The knowledge that the biological effects of x-rays and radium are due to secondary electrons is, of course, not new; electrons with an equivalent of 1.2 MEV have been used for more than fifty years in the so-called beta plaques of radium sources. Free beams of electrons in the multimillion volt range, however, have found only limited use because until very recently the technical facilities for their production were not available.

The advantages of utilizing electrons directly for treatment of malignant tumors localized in the depth of the body result from their characteristics. First, their range, and consequently their penetration, are determined by the primary energy. Second, the ionizing property in a free beam of electrons is not concentrated at its source, but is more homogeneously distributed and, therefore, more favorable than in the conventional beams of radiation produced by x-ray apparatus, radium, and cobalt-60 sources.

The penetration of electrons was roughly calculated as being about half the distance in centimeters as the creating energy in MEV. For practical purposes it was assumed that the formula $(\text{MEV}/2) - 1/2$ would be correct, indicating that a beam produced with an energy of 10 MEV would penetrate 4.5 cm., while a beam with an energy of 20 MEV would penetrate 9.5 cm., etc. A confirmation of such calculated data could, of course, be expected only after electrons in the multimillion-volt range had been produced. This was first accomplished in 1946, when a free beam of electrons was liberated from a 20-MEV betatron placed at our disposal

by Kerst for experimental purposes. Electron beams exceeding energies of 16 MEV were produced by Skaggs (2) and co-workers, who also undertook the collimation of such beams and the determination of isodose curves.

Continued research in this field convinced us that electron beams within this energy range were helpful but not sufficient for the clinical use which we visualized, and that electron sources with energies of at least 35 MEV and preferably higher should be available. The 20-MEV betatron used by us had never been intended for application in medical practice and offered no flexibility. Since we were fortunate in having the benefit of Kerst's knowledge, experience, and cooperation, we decided to develop a betatron with a capacity of 40 MEV or higher, specifically for medical purposes. This apparatus was intended to provide energies between 5 and 40 MEV and to have sufficient flexibility to permit convenient exposure of patients; it also should allow for easy determination of energy output and contain simple controls of the mechanical and electrical parts.

Blueprints for such an electron betatron were developed in our laboratory by Skaggs and Mueller, with the advice of Kerst and his staff, and were finished in 1951. At that time construction by a manufacturer willing to undertake this task was found to be impossible, due to the concentration of available facilities on government work in connection with the Korean conflict and rearmament program. On the basis of information at hand, it was estimated that work could not be started before late in 1953 or early in 1954, though there was, of course, no guarantee that such a date could be met. (As it turned out later, construction probably could have been

¹ From The Tumor Clinic of Michael Reese Hospital, Chicago, Ill. Accepted for publication in May 1955.

² Chief Engineer, Helene Curtis Industries, Inc.

started earlier than the conservative estimate had indicated.)

Forced to give up building plans, at least temporarily, for the 40-MEV betatron, we decided to investigate the possibilities of other sources of fast electrons, especially the linear electron accelerator. This apparatus had attracted our attention before we became aware of the development of the betatron by Kerst, but serious consideration of its construction had been abandoned when preliminary studies revealed that the desired energy of 40 MEV would require accelerator tubes with a length of 100 feet or more. It was reasoned that the development of such an apparatus would be far beyond the capacity of a laboratory in a private hospital.

On reconsidering this problem in late 1952, we learned that a linear electron accelerator with the desired energy had been developed by the Microwave Laboratory at Stanford University under the direction of Ginzton (3), with the support of the Naval Research Office. The development of a special klystron had made possible the construction of a linear accelerator with an energy of 40 MEV and an accelerator tube limited to 10 feet in length. This development appeared so promising that, after permission was granted by the Naval Research Office, we asked for and received the generous cooperation of Ginzton and his staff, enabling us to proceed with work on the apparatus to be described here.

Linear accelerators with lower energies have been built for more than twenty years. Their development was furthered by British physicists and engineers and their capacity for producing x-rays in the million-volt range was considered and utilized by British investigators for medical purposes. The relatively low energy (8-MEV installations for medical use) of these machines is probably the main reason why the production of electron beams was not attempted.

Our own endeavor was concerned with the construction of a useful and smoothly working source of electrons which would provide us with a free beam of electrons

applicable to therapeutic purposes. In addition to the source, auxiliary equipment for applying and monitoring the beam had to be installed to provide easy adjustment and control. Furthermore, consideration had to be given to assure complete protection of patient and personnel against unwarranted radiation. These problems were solved by provision of a separate building³ adjacent to and in connection with the existing Department of Therapeutic Radiology on the ground floor of the hospital.

The building is of reinforced concrete with basement space restricted to areas where exposure to ionizing radiation appears impossible. The area which houses the accelerator and the treatment room for patients is surrounded by reinforced concrete walls 3 feet thick. A layout of the installation is shown in Figure 1. The equipment is located in three separate, though connected, rooms. The high-voltage power supply, pulsers, vacuum systems, and all other facilities necessary for the production of the electron beam, including the accelerator tube, are in the accelerator room, which also houses a baking station and machine tools for mechanical and technical work in connection with maintenance and repair. Some essential parts in this room, the klystron, a spare klystron for replacement, the accelerator tube, the electron gun, and the klystron pulse transformer were procured from the Microwave Laboratory of Stanford University. The accelerator as a whole is built on the principle of the Stanford model.⁴

The accelerator tube is placed horizontally 7 1/2 feet above floor level and

³ The entire costs of the building and the construction of the linear accelerator were contributed by private donors and organizations. Suitable plaques acknowledging our gratitude to these public spirited individuals are installed in the building.

⁴ The accelerator was constructed in Chicago, by the Engineering Department of Helene Curtis Industries, Inc. This company provided the maximum of cooperation during the construction period and was also helpful in solving many of the adjustment and maintenance problems arising during the first year of operation. The owners of the company donated the major part of the construction costs.

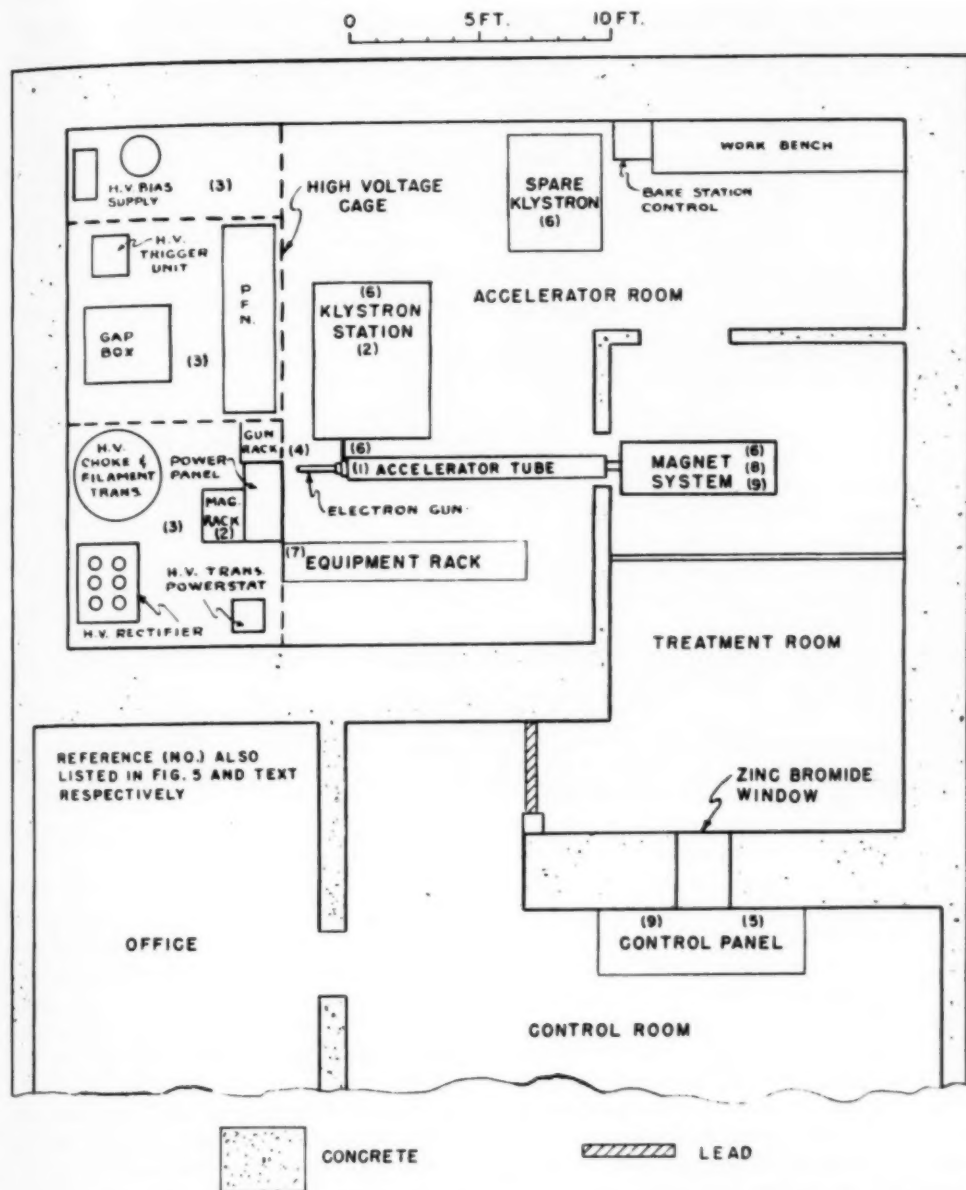


Fig. 1. Schematic layout of salient components of the linear electron accelerator in three rooms of a special building.

terminates in an opening in the wall adjacent to the treatment room. This room, like the machine room, is 14 feet high and houses in a portion of its upper part two electromagnets which are adjacent to and in line with the accelerator tube and serve

the primary function of bending the beam from a horizontal to a vertical direction, as well as additional functions which will be mentioned later.⁵ The magnet system

⁵ The magnets were designed in the department and engineered and constructed by Helene Curtis Industries.



Fig. 2. Treatment tube and tilting control box.

is surrounded by necessary protective shielding and can be rotated 45° to either side of the vertical axis. The entire magnet system, including the supporting framework, is enclosed in a steel frame lined with fiberboard and plastic tile, a structure which appears as a part of the room furnishings. Visible to the patient are merely the protruding treatment tube (Fig. 2) with its attached ionization chamber and a small panel with switches controlling the movement of the tube and four spotlights.

The treatment room is accessible from the control room through a protective maze of concrete walls 3 feet in thickness, and the patients are observed through a window filled with zinc bromide solution. The control panel (Fig. 3), placed directly under this observation window, contains all the devices necessary for the control of the accelerator, the magnet system, and the measuring instruments for the electron beam output. For testing and maintenance functions, direct communication between the control panel and the accelerator room is maintained through an intercom in addition to a telephone installation.

Principles of operation of the apparatus and the functions of the component parts may be described as follows: The linear electron accelerator consists of a disk-loaded tube through which an electromagnetic wave of a large axial electric field can travel with a phase velocity of nearly that of light. This wave, gen-

erated by a magnetron oscillator and amplified by a klystron amplifier, is coupled to the tube at the input end. Here a stream of electrons is also injected into the tube by a so-called electron gun. If properly adjusted, this electron stream will be accelerated to a velocity close to that of light within a space of a few inches and henceforth will ride on the waves. The electrons, traveling in step with the wave, are in a constantly accelerating field, and their energy increases in a linear manner at the expense of the energy of the wave. Closely analogous to this mode of acceleration is the surf-board rider being pushed by water waves. The acceleration achieved in this way, however, is inherently orbit-unstable; that is, the electrons tend to wander away before they arrive at the output end, either by moving radially outward and thus striking the disks of the tube or lagging farther and farther behind the crest of the wave and thus getting lost. Fortunately, these undesirable instabilities are greatly reduced by virtue of the relativity theory, and if the injection velocity is sufficiently high, the performance of the accelerator is not materially affected.

The salient features of our accelerator are illustrated in the simplified block diagram reproduced as Figure 4. Nine components (see Fig. 1 for relative location) are essential: (1) the accelerator tube, through which both electromagnetic waves and electrons propagate themselves; (2) the microwave power source (magnetron oscillator) and the klystron amplifier which excites the proper wave inside the tube; (3) the main high-voltage supply, which furnishes pulsed high-voltage for the operation of the klystron amplifier; (4) the electron gun, which produces bursts of high velocity electrons; (5) trigger generators for synchronization of pulsed; (6) various vacuum systems for evacuating the klystron, the accelerator tube, and the magnet chamber; (7) interlocks for protection of personnel and instruments; (8) a magnet system for control of energy, direction, and size of the output electron beam; (9) a monitoring system for meas-

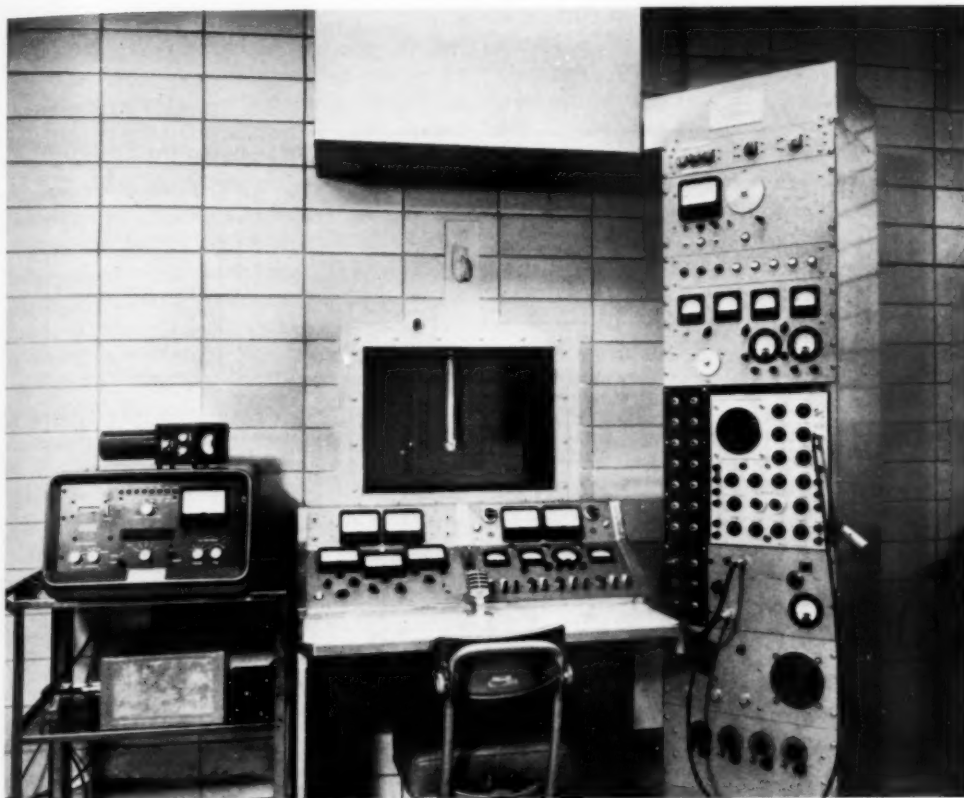


Fig. 3. Control panel for controlling and measuring beam characteristics (center and right) and radiation instruments (left). Patient-viewing window in center.

uring the beam intensity and control of the desired dosage to patients.

(1) *Accelerator Tube:* The accelerator tube is a disk-loaded wave guide made from oxygen-free, high-conductivity copper tubing and disks of selenium copper. The inside of the tube is highly polished and plated with pure gold to a thickness of 0.00001 inch. The disks are fixed in position by shrink fit, a process which consists essentially in first heating the tube to over 200° F. in a steam jacket, while cooling the disks, mounted on a mandrel, to -320° F. in liquid nitrogen, and eventually bringing the disks into the tube, at which time the steam is shut off. The contraction of the tube and their own expansion will tightly lock the disks in position. The gold junction electrical con-

tacts produced in this manner are far superior to those that can be obtained by soldering, and tight contacts are essential to the performance of the accelerator.

The total tube length of 10 feet used for the present accelerator is made up of five sections of 2 feet each. These sections are tightly pressed together by means of four tie rods. The ends of each section which make contact with the adjacent sections are hand-lapped to extreme flatness in order to obtain good electrical contacts as well as a tight vacuum. A guard vacuum between the O-ring seal and accelerator tube is incorporated to help maintain a high vacuum inside the tube.

The mechanical dimensions of the accelerator tube and disks are highly critical, from theoretical considerations, and the

NOTE ALL BLOCKS WITH * HAVE ELEMENTS THAT CAN BE VARIED DURING OPERATION FROM CONTROL ROOM PANEL.

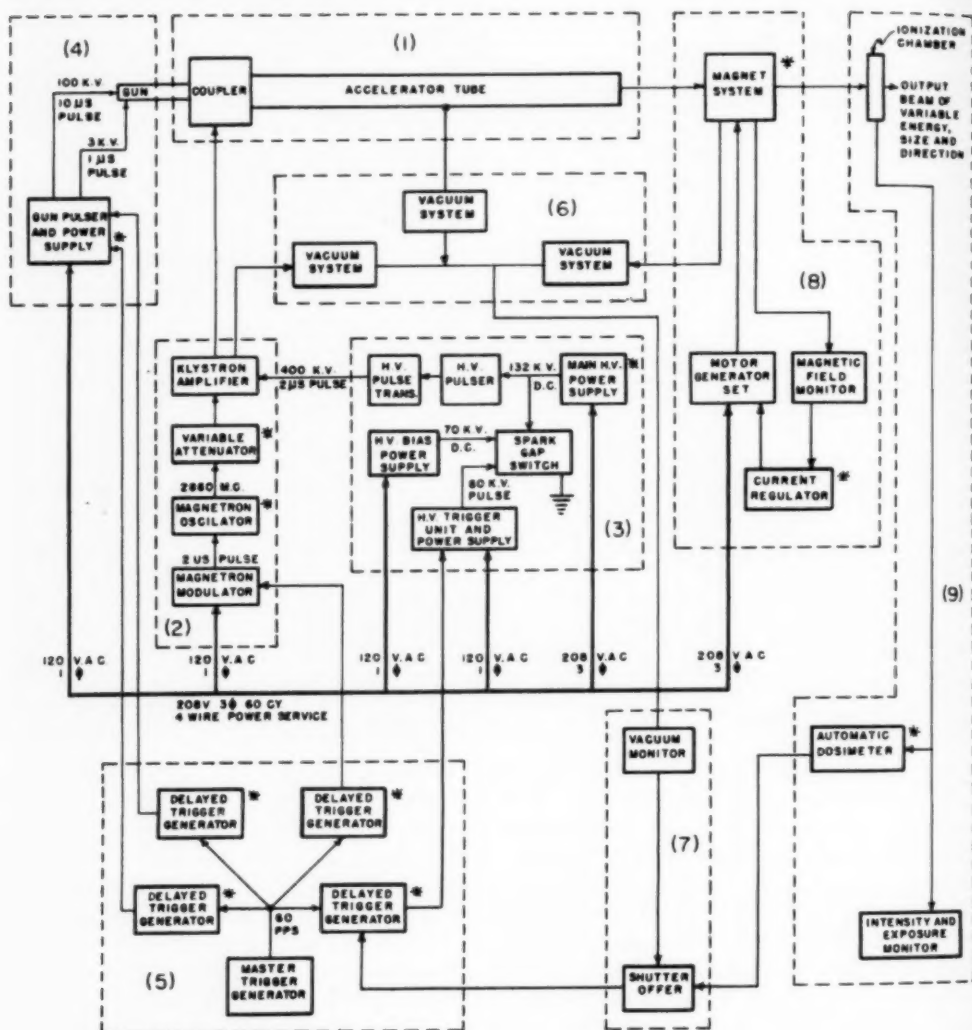


Fig. 4. Simplified block diagram of the 45-MEV medical linear accelerator.

tolerances of some critical dimensions are kept to within 0.0002 inch. To prevent undue frequency drift, it is necessary to maintain dimensional stability of the tube, which is accomplished by circulating temperature-controlled water through 1/4-inch cooling tubes soldered to the outside of each section. The whole tube is assembled and supported inside a steel housing to shield the earth magnetic field, which

otherwise might bend the electron beam. Excessive x-radiation from the accelerator tube is absorbed by filling the space between the tube and the steel housing with lead shot.

(2) *Microwave Power Source:* Microwaves (10.5 cm. wave length) are supplied to the accelerator tube through a coupler block by a klystron which derives its driving power from a Raytheon RK 5586

tunable magnetron. Neither the klystron nor the magnetron is continuously operative, but both are pulsed at the rate of 60 times per second, with a pulse length of 2 microseconds, since much higher power can be obtained with pulsed than with continuous operation. The higher the microwave power which is coupled to the accelerator tube, the higher will be the energy of the accelerated electrons.

The klystron used is a unique development of the Microwave Laboratory of Stanford University for this particular application (4). A peak power of 18 megawatts or more has reportedly been obtained. Based on this figure, the maximum output electron beam energy of 45 MEV is calculated.

Beside its primary function as a power amplifier, the klystron incidentally is a powerful source of x-rays, with an anode voltage of 400 kv. The maximum intensity is about 18 r/min. at 1 meter and lead shielding is therefore used to decrease this radiation to a tolerable level.

(3) *Main High-Voltage Supply:* The operation of the klystron requires a high-voltage source of 400 kv maximum, with 2 microsecond pulse duration; it is pulsed at 60 times per second. A power supply, consisting of a high-voltage rectifier circuit with d.c. output variable up to 70 kv, charges a pulse-forming-network (p.f.n.). The charging current flows through a choke of 700 henries which is in resonance with the total capacity of 0.029 microfarads of the p.f.n. The maximum available charging voltage is therefore nearly doubled (to 132 kv).

The p.f.n. includes ten 0.0029-microfarad oil-filled condensers designed to operate at 132 kv, 1,500 amperes pulse current, and inductances of 2.82 microhenries, consisting of three turns of 3/8-inch copper tubing, wound to a diameter of 13 inches, between condensers. This network has a characteristic impedance of 42.5 ohms and produces pulses of 2 microseconds duration. The end of this pulse line is connected to the primary of the klystron pulse transformer, which is

immersed in "Special Marcol" transil oil in a tank together with the lower part of the klystron. The pulse transformer has a step-up ratio of 6:1, and for matched condition furnishes a negative pulse of 400 kv maximum to the klystron cathode.

A spark-gap switch, which consists of six hollow copper balls, 3 inches in diameter, forming five gaps, is used to discharge the p.f.n. The firing of this switch is caused by a positive trigger pulse of about 60 kv, supplied by a high-voltage trigger amplifier and applied to the second ball while the first ball is grounded. In order to have this switch work over a wide range of charging voltages, proper spacing of gaps is required, as well as a constant 70-kv positive bias voltage, from a bias rectifier unit applied at the third ball. Air jets blowing at each gap are provided to quench the arc after firing. In order to reduce the noise of the gap breakdown, the gap switch assembly is enclosed in an acoustically shielded box.

(4) *Electron Gun:* The electron gun used during the first year of operation, together with its power supply and associated pulser, produces a stream of electrons with a velocity about one-half that of light, pulsed at 60 times per second with pulse lengths of about 7 microseconds. The triggering of the gun pulse is so arranged that the 2 microsecond radiofrequency pulse lies completely within the gun pulse. Since the radiofrequency energy takes 1 microsecond to fill the accelerator tube, electrons injected before the tube is filled, and others present when the radiofrequency field is decaying, will not obtain maximum acceleration. Thus, relatively low-energy electrons will be present, with a resulting broad-energy spectrum. To improve on this point, a different gun, which produces 1-microsecond pulses of electrons starting only after the tube has been filled with radiofrequency energy, and terminating before the field begins to decay, has been installed.

The electron injector used temporarily is a Pierce gun with a tungsten cathode as the electron emitter and a vane-gridded anode

IONIZATION
CHAMBER

OUTPUT
BEAM OF
VARIABLE
ENERGY,
SIZE AND
DIRECTION

(9)

INTENSITY AND
EXPOSURE
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aperture. This system produces a convergent electron beam focused along the axis of the accelerator at a point where a strong axial component of a radiofrequency field is well established.

The accelerator beam current can be varied by adjusting the tungsten filament current of the electron gun. During operation in the region of relatively low temperatures, with consequent low beam current, the variation in emission due to temperature fluctuation contributes to the drifting of accelerator output current, in addition to the frequency drift of the magnetron and the change of mechanical dimensions of the accelerator cavities caused by radio frequency power dissipation. This emission drift can be eliminated, however, by the use of current stabilizing circuits.

An improved electron gun, meanwhile installed, consists of a bombardment cathode with focusing ring, control guide, and an anode in front of it. The anode is grounded and the other electrodes are pulsed to -100 kv with 10 microsecond pulses. With these pulses alone, no electrons will be injected because the grid completely shields the field. If, however, during each high-voltage pulse, another small positive 1 microsecond pulse is applied between grid and cathode, a focused 1 microsecond duration electron beam will be injected into the accelerator tube. This gun affords an improved spectrum and makes possible a higher maximum energy.

(5) *Trigger Generators:* Trigger generators controlled by a master trigger generator, each with a properly adjusted delay, achieve synchronization of the pulses of the magnetron, klystron, and the electron gun. The triggers in each case discharge a p.f.n. through a thyratron tube in the respective pulser. Since the 100-kv, 10-microsecond pulse is the longest, it is fired first; the 3-kv 1-microsecond gun cathode pulse is timed to fire at the center of the 100-kv gun pulse. The magnetron and klystron triggers are then timed to fill the accelerator tube with microwave energy at the instant the electrons from the gun

are injected, that is, at the start of the 1-microsecond gun cathode pulse.

(6) *Vacuum Systems:* Separate vacuum systems are used for the klystron, the accelerator tube and transmission wave guide, and the magnet system, respectively.

The klystron, because of its tendency to gassing at high-power level of operation, and because its oxide-coated cathode is very susceptible to gas contamination, has to be continuously pumped to remove gas produced inside the tube or leaking into it through joints. Its vacuum system consists of a mechanical forepump with a capacity of 120 liters per minute, a 3-stage 4-inch oil diffusion pump, and liquid nitrogen cold trap. The vacuum measured with an ion gauge at the cold trap is about 10^{-7} mm. Hg with klystron idle heater power of 200 W. and about one order higher with full heater power of 800 W.

The accelerator and wave-guide vacuum is separated from the klystron system by a ceramic window through which microwaves pass with but little loss. The wave guide requires evacuation to avoid electrical breakdown of the intense microwave fields, and the accelerator tube needs the vacuum to prevent breakdown and scattering of electrons by collision with gas molecules. This system consists of the same items as the klystron vacuum, except that an additional mechanical fore-pump is used for the guard vacuum of the accelerator tube and two 2-inch vacuum valves, one behind the cold trap and the other ahead of the aluminum output window at the end of the accelerator. There is a "Veeco" 1/2-inch valve between the guard vacuum and the main vacuum which permits the use of both fore-pumps for roughing whenever the system has been "let-down."

The vacuum measured half way between cold trap and accelerator tube input is about 5×10^{-6} mm. Hg during operation. Due to the low conductance of the disk-loaded structure, however, even though the accelerator tube is being pumped at both ends, the pressure at the middle portion of the accelerator tube might be one order higher.

The magnet system, to be described later, as a unit structure can be electromechanically rotated 45° about the accelerator axis to either side of the vertical. To avoid the use of a rotating vacuum joint, the magnet system vacuum chamber is evacuated by a separate system consisting of a similar mechanical fore-pump and diffusion pump without the liquid nitrogen cold trap. The vacuum measured near the output end of the vacuum chamber where the pumps are located is 10^{-6} mm. Hg, while the pressure at the input end is five times higher.

(7) *Protective Interlocks:* For elimination of hazards due to high voltage and radiation, and for protection against damage to expensive equipment and instruments, a rather extensive protective interlocking system has been installed. For personnel protection, door switches are used which make the high-voltage system inoperative when either the treatment room or accelerator room doors are open; furthermore, the treatment room door is always locked during operation of the apparatus and can be unlocked only by one of two keys taken from a master keyboard at the control panel. The removal of one shuts off the high voltage of the electron gun and the other that of the magnetron oscillator. In either case, the main sources of radiation hazards from the accelerator are thus eliminated. Three more keys, for the doors of the high-voltage pulser cage, the high-voltage rectifier cage, and the cover of the klystron oil tank, respectively, are interlocked in such a way that the removal of any one of them will break the high-voltage circuit, a feature designed for protection of the personnel servicing these regions.

Furthermore, warning lights and push-button switches are installed at strategic locations inside the treatment and accelerator rooms. The former are used to indicate the proper stage of the operation of the machine, while the latter are for the protection of personnel who might accidentally be trapped in these rooms. Pushing any one of these switches will prevent the application of high voltage from the control panel unless the accelerator room is

entered and a certain switch reset by the operator.

Once the treatment room door is locked and all keys are in position on the control panel, a chime will sound for ten seconds before high voltage can be applied. This acoustic signal serves as additional warning to anyone who may happen to have stayed in a dangerous area.

For protection against equipment damage, the following interlocks are provided:

- (a) *Diffusion pumps and ion gauges:* The diffusion pump heater and the filament of the ion gauge will automatically be turned off in case of failure of cooling water or if pressure is increased over the preset pressure scales as a result of breakage, etc.
- (b) *Vacuum systems:* Any vacuum failure during the regular working hours is indicated by a buzzer alarm. In off-hours, a remote alarm coupled to a program clock, at the telephone exchange switchboard of the hospital, will sound, enabling the operator to inform staff members of the failure.
- (c) *Klystron:* A shutter-off circuit will prevent the application of the high-voltage trigger if the klystron vacuum deteriorates beyond a predetermined level. Heater power and focusing fields have to be at a proper level, and cooling water for the collector, focusing coils, and lead apron inside the oil tank must be circulating, before the high voltage can be applied.
- (d) *Electron gun and accelerator tube:* The gun filament power cannot be turned on and high voltage cannot be applied unless the cooling air for the gun cathode and cooling water for the accelerator are first turned on.
- (e) *Spark gap:* No trigger high voltage can be applied if the air jets are not blowing at the gaps.
- (f) *Overvoltage:* If the charging voltage is too high, the high-voltage trigger will be shut off automatically.
- (g) *Overcurrent:* If the high-voltage charging current is excessive, a high-voltage

contactor will automatically be opened and thereby discontinue overloading.

(8) *Magnet System:* The electron beam emerging from the horizontally placed accelerator tube is not suitable for therapeutic applications, since it consists of electrons with various energies, and the slow drift of optimum tuning, due to various factors, makes it difficult to maintain even this beam. Therefore, a magnet system is necessary for proper operation.

Two wedge-shaped magnets are used for controlling the energy of the beam, as well as its size and direction. The first magnet, located immediately at the output end of the accelerator tube, bends a beam of the desired energy upward 45° from the horizontal and functions as an energy selector. Corresponding to a fixed magnetic field, the energy of electrons along that direction is definitely fixed; electrons with other than this particular energy will follow different paths. A slit box, located between the first and second magnets, allows passage of only those electrons which are near 45° to the horizontal and stops all others. Electrons which have passed through the slit are therefore practically mono-energetic. These electrons enter the second magnet, of 135° wedge-angle, which has a magnetic field opposite in direction to the first. This magnet will bend the electrons downward to the target, which is placed in an area accessible to or in reach of an extension tube. The magnet system, as a whole, can be rotated about the axis of the accelerator tube to 45° either side of the vertical. This makes it possible to direct the beam at various convenient angles to the target.

For fields of various dimensions, it is necessary to adjust the beam size over a considerable range at the target plane. Furthermore, the electrons should be uniformly distributed. These objectives can be achieved by first broadening the beam through scattering and then defining the field by a cone of Lucite or similar material. Since the atomic numbers of these materials are low, x-rays produced by stopping

the scattered beam are not very intense; however, considerable amounts of x-radiation, depending on the number of electrons stopped, will unavoidably mix with the latter. This method is simple and has generally been adopted by investigators using betatrons as sources of electrons.

A different approach has been used by us in an endeavor to secure a "cleaner" beam. The arrangement of physical components is such that electrons will encounter no obstacles in their downward travel, thus eliminating the possibility of an admixture of x-rays. To be sure, the generation of x-rays is unavoidable when the unused electrons strike the slit box, etc. But these x-rays are not in the final direction of the beam and can be separated; furthermore, patients will not be in the forward path of the x-rays and can be protected against oblique radiation with relatively little shielding.

The means used for the production of rectangular fields of various dimensions consist essentially of varying the exit pole tip angle of the 135° magnet and, in certain cases, of varying the slit width and entrance pole tip angle. Since the energy resolution of the beam at the target plane is related to the slit width, the field size and energy resolution are interdependent. The design parameters are so chosen, however, that even for the largest fields (12×12 cm.), the energy resolution is well within 2 per cent and, therefore, its effect can be ignored. The field dimensions in the direction perpendicular to the axis of the accelerator tube depend solely on the pole tip angles due to fringe-field focusing, but those in the direction of the axis of the accelerator vary with both pole tip angles and slit width. By proper combination of these parameters, any field size from 1 cm. to 12 cm. in either direction can be obtained at will.

Since the energy stability at the target is proportional to the constancy of the magnetic fields, current regulators are used to stabilize the currents through the 45° and 135° magnet coils furnished by two D.C. generators of 6 and 12 volts, respectively.

The magnetic field intensities are measured by synchronous motor-driven pick-up coils and thus, hysteresis of the magnet need not be considered, as in monitoring of the magnet currents, and quick changes of energy can be made.

(9) *Monitoring Devices:* The output current of the accelerator delivered to the target is measured with a parallel plate ionization chamber clamped to the end of the extension tube of the 135° magnet. The chamber reading is calibrated with a Faraday cage at different energies.

For delivering a predetermined dose to a patient, an automatic dosimeter is used. It is essentially a negative feed-back electrometer circuit with grid voltage proportional to the dose delivered and an adjustable reference voltage in the plate circuit to determine the right moment for triggering the shutter-offer circuit which shuts off high-voltage pulses.

For experimental and adjustment purposes, a manually controlled intensity, integration, and exposure meter circuit is also included. The usefulness of this meter consists in the proper indication of the tune-up, and it can therefore be used to correct the drift of optimum tuning during the treatment.

This brief description of the linear accelerator and its component parts should facilitate an understanding of its functions. Having had some experience with an experimental model of the 20-MEV betatron and, for one year, with the linear accelerator, we are often asked which instrument is preferable for medical application. In trying to arrive at an answer we must emphasize that the betatron used by us was not intended for medical application, whereas the linear accelerator was designed and constructed with that goal in mind; furthermore, since—with the exception of the size of the magnets—we had exact knowledge of the space requirements, we could adapt our building plans in such a

manner as to provide for the most satisfactory operation of the machine and most convenient care of the patients.

In our opinion, the linear accelerator offers definite advantages as a source of electrons for medical therapeutic purposes. One important point is the absence of noise and the quiet operation of the machine. Another favorable feature is the straightforward linear beam, which does not require any specific gadgets, such as a magnetic shunt, for liberation of the electrons from the apparatus. Third, all parts of the machine are readily accessible, and maintenance offers no particular problems. Fourth, sufficient flexibility allows for accommodation of even very sick patients. Fifth, the magnet system used by us provides for a wide variety of field sizes which can easily be adjusted to the treatment of defined areas in individual patients. Finally, our installation, though using little shielding, reduces the gamma-ray background at the target to an inconsequential amount, which presents no special problem or hazard.

All these considerations recommend the linear accelerator as a convenient instrument for treatment of cancer patients with fast electrons.

The linear electron accelerator has been in experimental operation for over one year. We intend to correlate the data thus obtained for future publication.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

El Acelerador Lineal de Electrones como Foco de Electrones Veloces para la Terapéutica del Cáncer

Descríbense la construcción y el funcionamiento de un acelerador de electrones que, según los AA., posee ventajas bien definidas como foco de electrones para fines de medicina terapéutica. Un punto importante es el funcionamiento silencioso del aparato. Otra característica favorable es el haz lineal recto, que no requiere ningún accesorio específico, tal como un desviador magnético, para emitir electrones del aparato. En tercer lugar, todas las partes del aparato son de fácil acceso y la conservación no entraña mayores problemas. Cuarto, una flexibilidad adecuada

permite acomodar hasta a sujetos muy enfermos. Quinto, el sistema de imanes ofrece una vasta variedad de tamaños en los campos, que pueden ajustarse fácilmente para el tratamiento de zonas bien definidas en enfermos dados. Por fin, esta instalación, aunque utiliza poco resguardo, reduce el fondo de rayos gamma en el blanco a una proporción insignificante, de modo que no encierra mayor riesgo.

Este acelerador ha estado en funcionamiento experimental por más de un año, pero no se ofrecen aquí datos en cuanto a los resultados.



A Comparative Clinical Trial of Urographic Media: Renografin, Hypaque, and Urokon

W. R. EYLER, M.D., D. R. DREW, M.D., and A. W. BOHNE, M.D.

A CONTRAST MEDIUM producing a uniformly good excretory urogram without hazard to the patient or objectionable reaction has not yet become available. There has, however, been considerable progress in this direction in the last few years, largely due to the efforts of the pharmaceutical manufacturers.

The introduction of sodium 3 acetyl-amino-2,4,6-triiodo-benzoate, marketed as "Urokon Sodium," was an advance in reducing local and systemic reactions (1). Recently, the compound 3,5-diacetyl-amino-2,4,6-triiodo-benzoic acid, available as a sodium salt, has been marketed as "Hypaque," and under the trade name "Renografin" has been supplied as a combination of sodium and methylglucamine salts. This material has been used in Europe since 1952 (2-4) as "Urografin." "Renografin" contains 76 per cent total solids, 59.6 per cent base, and 36.9 per cent iodine. "Hypaque" is a 50 per cent solution of the sodium salt and contains 29.9 per cent iodine. Urokon Sodium, 50 per cent, contains 32.9 per cent iodine, and Urokon Sodium 70 per cent contains 56.1 per cent iodine.

Previous work at our hospital (5) had convinced us that the higher concentrations of Urokon produced better urograms, and it was therefore decided to use these for comparison with the other agents. In each case, a 20 c.c. syringe was used with as much of the contrast agent as could be readily handled; as the Renografin ampule contains only 20 c.c., slightly less of this material was used than of the other agents.

The material upon which our observations were based consisted of 900 urograms of unselected patients. In the first part of the study, the syringe was filled by a

TABLE I: RESULTS WITH UROKON

| | Urokon 70% | Urokon 50% |
|--------------------------|---------------|---------------|
| Reactions | (%) | (%) |
| Nausea | 20 | 24 |
| Vomiting | 6 | 5 |
| Dizziness | 4 | 5 |
| Pruritus | 6 | 1 |
| Hives | 9 | 7 |
| Dyspnea | 0 | 1 |
| Anaphylaxis | 0 | 0 |
| Sweating | 2 | 1 |
| Arm pain | 12 | 4 |
| Some reaction (any type) | 37 | 35 |
| Quality of Films | | |
| Excellent | 13 | 19 |
| Good | 62 | 46 |
| Fair | 20 | 25 |
| Poor | 5 | 10 |

nurse, who made a note of the agent used. The injection, the recording of reactions, and the evaluation of the films were all done by physicians who had no knowledge of which medium had been employed. Table II presents the results.

In the second part of the study an additional 300 Renografin urograms were obtained. During this period, the injections were made by nurses, the reactions were recorded by technicians, and the quality of the film was assessed by the physician, who knew what agent had been used. This part of the study was done principally to obtain information about reactions to Renografin which would have more statistical significance. An ideal study should be large enough to include a number of serious reactions; only one occurred.

Table I shows the similarity of reaction rate with the two concentrations of Urokon, and the distribution of film quality. In Table II, presenting the results with all three media, the figures for the two concentrations have been considered together, under the heading Urokon 50-70 per cent.

Table III compares the results of the

¹ From the Henry Ford Hospital, Detroit, Mich. (W. R. E., Radiologist-in-Chief; D. R. D., Senior Resident in Radiology; A. W. B., Physician in Charge, Division of Urology). Presented at the Forty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 11-16, 1955.

The materials used in this study were generously supplied by the manufacturers.

TABLE II: RESULTS WITH RENOGRAFIN, UROKON, AND HYPAGUE

| | Renografin | Urokon 50-70% | Hypaque |
|-----------------------------|------------|------------------|---------|
| Reactions | (%) | (%) | (%) |
| Nausea | 10.5 | 22.0 | 13.0 |
| Vomiting | 4.5 | 10.5 | 4.0 |
| Dizziness | 2.5 | 4.5 | 1.5 |
| Pruritus | 0 | 3.5 | 0.5 |
| Hives | 1.0 | 8.0 | 3.5 |
| Dyspnea | 0 | 0.5 | 0.5 |
| Anaphylaxis | 0 | 0 | 0.5 |
| Sweating | 0 | 1.5 | 0.5 |
| Arm pain | 0 | 8.0 | 1.0 |
| Some reaction (any type) | 12.5 | 36.0 | 17.0 |
| Quality of Films | | | |
| Excellent | 13.5 | 16.0 | 21.0 |
| Good | 45.5 | 54.0 | 52.5 |
| Fair | 31.5 | 22.5 | 18.5 |
| Poor | 9.5 | 7.5 | 8.0 |

first 200 cases in which Renografin was used with the additional 300 cases in which evaluation was made by physicians who knew what agent had been employed.

Since the base of Hypaque and Renografin is the same, the similarity of reaction rate and film quality is not unexpected. The one serious reaction of anaphylactic type occurred with Hypaque. The relatively small number of cases in the groups and the fact that there was only one such side-effect make it impossible to draw any conclusion concerning the relative frequency of this type of reaction with the various media. The less important effects—nausea, vomiting, dizziness, pruritus, hives, and arm pain—were appreciably less

TABLE III: RESULTS IN TWO RENOGRAFIN SERIES

| | Renografin 200 Cases Control Study | Renografin 300 Cases Second Study | Renografin 500 Cases (Total) |
|-----------------------------|---|--|------------------------------------|
| Reactions | | | |
| Nausea | 10.5 | 19.0 | 15.6 |
| Vomiting | 4.5 | 4.7 | 4.6 |
| Dizziness | 2.5 | 8.3 | 6.0 |
| Pruritus | 0 | 3.0 | 1.8 |
| Hives | 1.0 | 1.0 | 1.0 |
| Dyspnea | 0 | 0 | 0 |
| Anaphylaxis | 0 | 0 | 0 |
| Sweating | 0 | 0.3 | 0.2 |
| Arm pain | 0 | 2.3 | 1.4 |
| Some reaction (any type) | 12.5 | 27.0 | 22.0 |
| Quality of Films | | | |
| Excellent | 13.5 | 10.3 | 11.6 |
| Good | 45.5 | 56.7 | 52.2 |
| Fair | 31.5 | 24.0 | 27.0 |
| Poor | 9.5 | 9.0 | 9.2 |

TABLE IV: SUMMARY OF RESULTS WITH THREE MEDIA

| | Renografin | Urokon 50-70% | Hypaque |
|-----------------------------|------------|------------------|---------|
| | (%) | (%) | (%) |
| Some reaction (any type) | 12.5 | 36.0 | 17.0 |
| Diagnostic films | 90.5 | 92.5 | 92.0 |
| Unsatisfactory films | 9.5 | 7.5 | 8.0 |

TABLE V: CORRELATION OF AGE WITH PYELOGRAPHIC QUALITY IN 900 CASES (ALL CONTRAST MATERIALS)*

| Age | Cases in Group | Excel- lent | Good | Fair | Poor |
|-------|----------------------|----------------|------|------|------|
| | | (%) | (%) | (%) | (%) |
| 0-19 | 56 | 23.2 | 60.7 | 12.5 | 3.6 |
| 20-29 | 79 | 24.1 | 54.4 | 16.5 | 5.0 |
| 30-39 | 148 | 25.0 | 56.8 | 14.9 | 3.4 |
| 40-49 | 174 | 16.1 | 53.5 | 24.1 | 6.3 |
| 50-59 | 212 | 9.4 | 56.1 | 28.8 | 5.7 |
| 60 + | 231 | 6.9 | 41.6 | 33.3 | 18.2 |

*Percentages are based on number of cases in the particular age group.

in the Renografin and Hypaque groups than in the Urokon series. The most marked difference between Urokon and the other agents was the higher incidence of arm pain with the former.

An interesting by-product of the study was the opportunity to correlate the age of the patient with pyelographic quality. The results of this correlation, seen in Table V, are what might be expected. The first age group to have less than 20 per cent excellent pyelograms was that of the sixth decade. Patients fifty years of age and older had less than 10 per cent excellent pyelograms. At the other end of the scale, those below sixty gave from 3.4 to 6.3 per cent unsatisfactory pyelograms, while the figure for those over sixty was 18.2 per cent. These figures were compiled on the basis of data from all of the contrast materials.

SUMMARY

A total of 900 urograms and the reactions incident to their production were studied. The media used were Renografin, Urokon in two concentrations, and Hypaque.

Only one serious reaction of anaphylactic type occurred (Hypaque), but a single case

THREE MEDIA

| Hypaque |
|---------|
| (%) |
| 17.0 |
| 92.0 |
| 8.0 |

UROGRAPHIC
MATERIALS)*

| Poor |
|------|
| (%) |
| 3.6 |
| 5.0 |
| 3.4 |
| 6.3 |
| 5.7 |
| 18.2 |

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does not warrant any conclusion about the relative frequency of this reaction with the various media.

Renografin and Hypaque both showed a lower incidence of minor side-effects than did Urokon.

Urograms made with Renografin, Hypaque, and Urokon 50 and 70 per cent were comparable in diagnostic quality.

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SUMARIO

Ensayo Clínico Comparado de Medios Urográficos: Renografin, Hypaque y Urokón

Este estudio comprendió un total de 900 urogramas y las reacciones incidentes a su obtención. Los medios usados fueron Renografin, Urokón, e Hypaque.

No hubo más que una reacción grave de forma anafiláctica (Hypaque), pero un solo caso no justifica sacar conclusiones acerca de la relativa frecuencia de esta reacción

con los varios medios. Tanto el Renografin como el Hypaque revelaron una incidencia menor de pequeños efectos colaterales que Urokón.

Las radiografías tomadas con Renografin, Hypaque, y Urokón al 50 y 70 por ciento fueron comparables en calidad diagnóstica.



Hematoma of the Duodenum

A Case Report¹

MYRON MELAMED, M.D., and ANTON M. PANTONE, M.D.

GASTROINTESTINAL symptoms which are related to recent trauma may be associated with a hematoma involving the bowel. This is thought to occur in a significant number of patients who experience abdominal injury. The recent literature contains several examples of the radiographic demonstration of such hematomas (2-6). The case to be reported here was not surgically or pathologically verified, but the clinical and radiographic evidence is conclusive. This patient was treated conservatively and characteristic radiographic changes in the duodenum completely regressed in a few weeks.

R. S., a 19-year-old white girl, was admitted to Grant Hospital, Chicago, on Dec. 10, 1954. Two days earlier she had struck her right side on the steering wheel of her car in an automobile accident. She felt no immediate ill effects, but during the next thirty hours nausea, vomiting, and abdominal pain occurred, leading to hospitalization.

The only significant findings on physical examination were an ill-defined mass in the right upper quadrant of the abdomen and upper abdominal tenderness. The pulse rate was 104 per minute. Blood pressure, temperature, and respirations were normal.

Laboratory studies revealed a red cell count of 4,180,000, hemoglobin 12.5 gm., and white blood cells 10,800. The red cell count fell to 2,960,000 within three days, but returned to normal during the patient's hospital stay. Repeated urine studies disclosed no abnormality.

Roentgen Studies: A plain film of the abdomen on Dec. 11 showed possible dilatation of the stomach. An upper gastrointestinal tract examination on Dec. 20 revealed no obstruction to the flow of barium through the second portion of the duodenum. An unusual deformity of this segment with a crescentic defect, suggesting at least a partially intramural tumor, was demonstrated (Figs. 1 and 2). The lumen in the involved segment was slightly narrowed. In addition, there was a constant collection of barium in the descending duodenum on several films, considered as most likely representing a small mucosal ulceration (Fig. 3). The diagnosis of hematoma

of the duodenum was made. Since there was no evidence of complete obstruction, the patient was treated conservatively. Gradual improvement ensued and she was discharged on Jan. 2, 1955.

A repeat upper gastrointestinal tract examination one month after the initial study (after hospital discharge) revealed an essentially normal appearing descending duodenum, with only very slight irregularity of contour (Figs. 4 and 5).

DISCUSSION

Hematomas of the bowel may be localized intramural tumors, usually subserosal in position, or they may be associated with retroperitoneal or mesenteric components. We believe that the case presented here represents a duodenal hematoma with other retroperitoneal involvement.

Hematomas have been described in the duodenum (1, 2), small bowel (5, 6), and colon (3, 4). There is an apparent predisposition to their occurrence in the duodenum following trauma, as a result of the relative fixation particularly at the duodenojejunal junction. Blood dyscrasias are known to be a predisposing factor.

Roentgen features of intestinal hematomas, particularly in the duodenum, are considered rather distinctive by Felson and Levin (2). These consist of a smooth, sharply margined intramural mass and a crowding together of the valvulae conniventes in the involved area, producing a "coil spring" appearance. Our case showed roentgen changes similar to those described by Felson and Levin, though a typical "coil spring" mucosal pattern was not demonstrated. In addition, a small patch of barium seen in the involved segment on several films was thought to represent an ulcer crater. A similar finding has been described by Liverud (6) in a hematoma of the jejunum. No obstruction at the site of involvement was noted in our case.

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Fig. 1. Intramural tumor of the descending duodenum with sharply margined border.
 Fig. 2. Compression study of abnormal segment of descending duodenum showing intramural tumor and slightly narrowed lumen without obstruction. A typical "coil spring" appearance of the mucosa is not demonstrated.



Fig. 3. Film of abdomen one hour after barium ingestion showing a collection of barium in descending duodenum, also seen on other roentgenograms. This may represent a mucosal ulceration.
 Fig. 4. Examination one month after initial gastrointestinal series, revealing almost complete restoration of duodenum to normal.

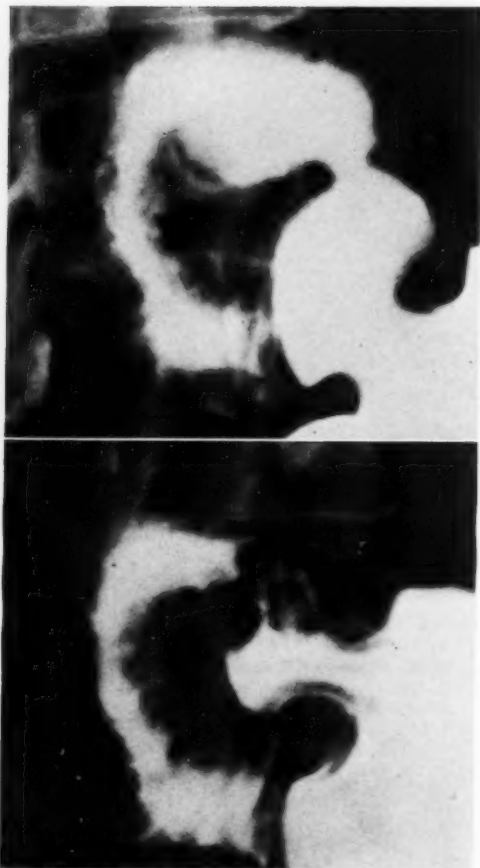


Fig. 5. Compression films of descending duodenum after one month, showing only slight irregularity of contour; appearance otherwise normal.

The history of trauma to the abdomen followed by gastrointestinal symptoms should lead one to consider the possibility of hematoma. Roentgen signs of duodenal hematoma are: intramural tumor-

faction with sharply demarcated margins; narrowing or obliteration of the normal duodenal lumen; a mucosal "coil spring" pattern; an unusual collection of barium in the involved bowel segment, which may represent a mucosal ulceration; disappearance of the radiographic findings with reversion to normal in follow-up studies.

The importance of the radiographic diagnosis is stressed, inasmuch as surgical intervention may be avoided in the absence of complete obstruction or accompanying lesions.

SUMMARY

A case of hematoma of the duodenum demonstrated radiographically is presented. A history of trauma to the abdomen, followed by gastrointestinal symptoms and radiographic findings characteristic of an intramural tumor, permit the diagnosis of such lesions.

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SUMARIO

Hematoma del Duodeno. Presentación de un Caso

Preséntase un caso de hematoma duodenal descubierto radiográficamente a continuación de un traumatismo abdominal. Los signos radiográficos de esos hematomas en el duodeno son: tumefacción intraparietal de bordes netamente demarcados; estenosis u obliteración de la luz duodenal

normal; patrón en "muelle" de la mucosa; inusitada aglomeración de bario en el segmento intestinal afectado, que puede representar ulceración de la mucosa; desaparición de los hallazgos radiográficos con retorno a lo normal en los subsecuentes estudios de observación.

Radiation Dosimetry in Biological Research¹

COMDR. J. E. MORGAN, MSC, USN, and F. ELLINGER, M.D.

AN IMPRESSION has prevailed among many physicists that biological research data are necessarily less accurate than physical data. The apparent lack of uniformity among living experimental subjects has seemed, to those accustomed to dealing with more rigidly controllable inanimate material, an almost insurmountable obstacle to satisfactory reproducibility of results. Modern statistical methods, however, together with painstaking care in the selection and handling of animals (1) now permit an order of accuracy in radiobiological experiments that constitutes a challenge to the highest precision attainable by physical dosimetry. It seems appropriate, therefore, to discuss briefly methods which have been found helpful in minimizing some of the more obvious sources of dosimetric uncertainty.

Three major types of x-ray generators are currently in use for animal irradiation experiments in the Naval Medical Research Institute: a Picker 220-kvp therapy unit, a General Electric 250-kvp "Maxitron," and a 2-MEV Van de Graaff originally built by the Massachusetts Institute of Technology. Various modifications and accessories found desirable in each instance for improved performance and/or stability are enumerated. Any reference in the following pages to the product of a particular manufacturer does not necessarily mean that to be the only source or even the best, but indicates rather that it happened to be available and was found to function satisfactorily in the application described.

MATERIALS AND METHODS

The *Picker 220-kvp* therapy unit is a standard hospital type which has proved

particularly useful in irradiation of small animals at voltages between 140 and 200-kvp (2). In this range, the output intensity has been found to vary as the second, or a slightly higher, power of tube potential. An uncompensated 2 per cent variation in line voltage will therefore produce an error in dose rate of nearly 5 per cent. When the dose-action curve is critically steep, such a degree of dosimetric uncertainty may produce serious differences in mortality, as has been demonstrated in experiments with mice (1).

In Figure, 1, the dotted outline at the upper left indicates insertion of a General Electric 5-kva stabilizer in the incoming power line. Under the steady operating load of the Picker machine, line fluctuations as great as ± 10 per cent are reduced to the order of 0.5 per cent or less. This saturated core type of regulator is simple and rugged, has no moving parts, and in six years has required no repairs or maintenance. The added cost represents only about 5 per cent of the total investment. It should be mentioned that, in this instance at least, installation of the line stabilizer caused some tendency to feedback and unsteadiness in the built-in filament stabilizer (which is of very similar design, although considerably smaller). Since, however, separate regulation of the filament supply is unnecessary when the entire line is adequately controlled, the filament unit was simply removed from the circuit.

One inherent difficulty in applying the conventional tapped auto transformer control unit to precision work is the stepwise potential selector. On the Picker machine, the smallest increment of the "minor" switch is approximately 3 kvp. It is

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The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the Navy Service at large.

obvious that there will be times when tube voltage can be adjusted no closer than ± 1.5 kvp to the desired value. Furthermore, as a consequence of normal warm-up drift, the high-tension circuit must be shut off, the selector setting changed, and the tube voltage built up again *via* the rheostat

The total cost of the components mentioned is only a few dollars, and the installation time about one hour.

Another potentially significant source of dosimetric error was discovered by accident, when an auxiliary meter and filament reactor were installed at a point re-

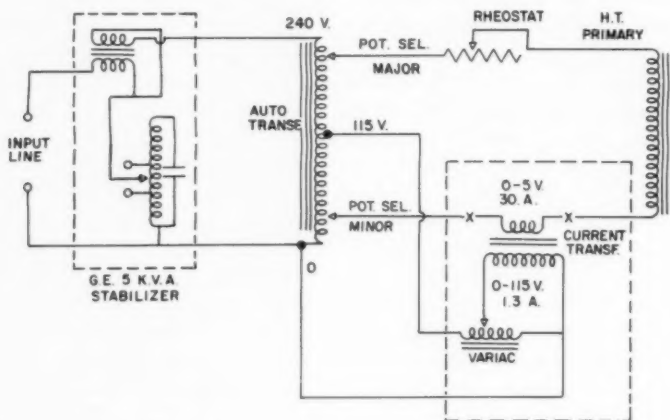


Fig. 1. Line voltage stabilizer and high-tension vernier adjustment applied to basic x-ray control circuit.

several times during each of the longer exposures in order to maintain even this degree of approximation. Some kind of continuously variable adjustment is urgently needed but, since the primary of the high-tension transformer draws nearly 30 amperes at full load, a "Variac" type control of adequate current rating would be prohibitively large for the space available. In the dotted outline at the lower right in Figure 1, however, an arrangement is indicated which provides smooth vernier action between steps of the regular potential selectors by means of a very small (General Radio Model V-2) Variac, conveniently mounted on the control panel. The 0-115-volt output of this low-current Variac is converted by a suitably compact stepdown transformer (Chicago Model F530) to 0-5 volts at 30 amp. and applied as a variable additive in series with the high-tension primary input. An ample range of fine adjustment (approximately 9 kvp) is thus available without shutting off the machine to change selector taps.

more from the Picker control console for more convenient access by the relief operator. A steadily increasing deviation between meters, observed through the first several hours of each working day, was found to be due largely to thermal drift of the panel meters. Hanging an aluminum baffle sheet between the rheostat coils and the nearby kilovolt meter eliminated most of the direct heat radiation, while installation of a large centrifugal blower (dark-room ventilator type) in one of the two existing cooling apertures at the top of the control cabinet effectively lowered the overall ambient temperature. The original warm-up drift of 6 per cent in three hours is thus reduced to less than 2 per cent, which in turn is fully compensated by an occasional slight adjustment of the manual kv vernier. Figure 2 shows the cooling blower mounted on top of the cabinet, with the Variac control knob at right center near the exposure timer.

The 250-kvp Maxitron generator unit has the same electrical characteristics as

the regular General Electric therapeutic model but has been stripped of cones, filters, shutter, tube stand, and all other accessories not directly essential to its basic function. The transformer tank and tube assembly are suspended vertically from a chain hoist near the center of a 20 X 20-foot exposure room, with power cables led from above and water lines from below, to permit an unobstructed lateral field (Fig. 3). The specially designed 90° anode x-ray tube, which covers a radially symmetrical area for simultaneous exposure of relatively large numbers of animals, has been described previously (3). At 250 kvp and 30 ma., with inherent filtration of 1.3 mm. Cu, it delivers approximately 18.5 r/minute at 100 cm., with a half-value layer of 3.3 mm. Cu.

In the region of 250 kvp, the dependence of x-ray output upon exciting voltage begins to approach a third power relation, so that unstable line conditions present an even greater problem than in the 140-to-200-kvp range discussed in connection with the Picker unit (p. 877). Unfor-

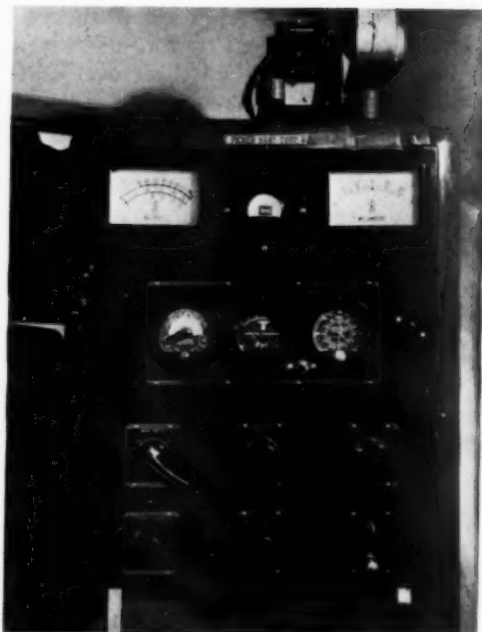


Fig. 2. Picker control panel, showing cooling blower (top) and Variac adjusting knob (right center, beside the exposure timer).

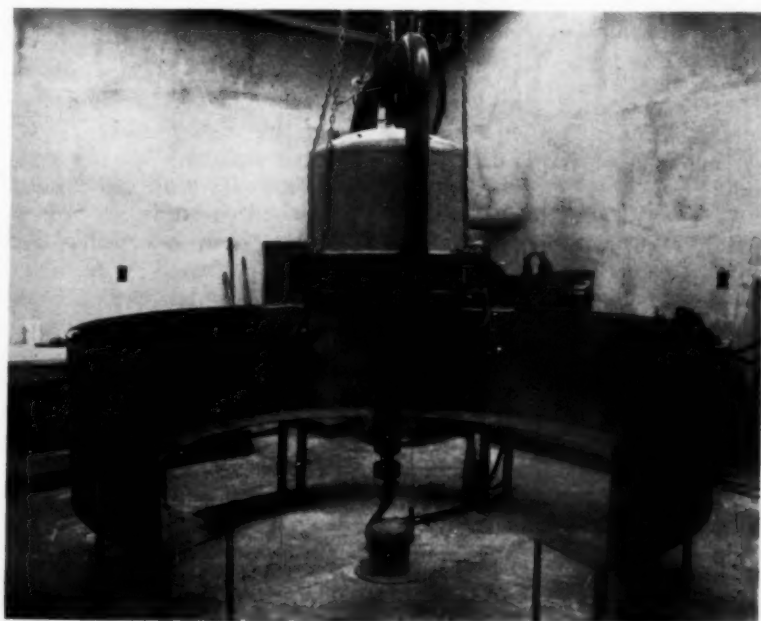


Fig. 3. Maxitron set-up for radial beam operation (one section of circular exposure bench removed for visibility).

tunately, any of the stabilizers of the saturated core type, such as the one which proved so satisfactory for the Picker unit, is highly sensitive to changes in load power factor. Again, unfortunately, the continuously variable kilovoltage control of the Maxitron is remotely operated by an a.c. motor, with starting surges which play complete havoc with phase angles. Due to

second/volt response time. Actual performance has been found at least equal to those standards. Figure 5 shows the two regulators installed on a shelf under the control table. The cost of these General Radio units per kva is approximately comparable to that of the General Electric model previously described.

The kilovolt indicator on the Maxitron

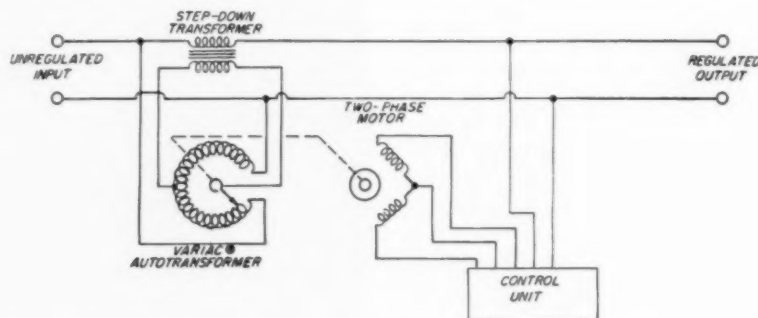


Fig. 4. Simplified circuit diagram of the General Radio Type 1570 Voltage Regulator. Reproduced by permission of the General Radio Co., Cambridge, Mass.

the complex interconnections of this motor with other sections of the x-ray power pack, it was found impracticable to supply the necessary driving current from an external source.

A type of voltage regulator which operates on entirely different principles, and thereby overcomes those particular difficulties, was supplied by the General Radio Company. This is essentially a Thyatron-controlled, motor-driven Variac, which superposes a "buck or boost" voltage on the incoming line as needed to compensate for fluctuations. It will be noted (Fig. 4) that a relatively small Variac is used, through a stepdown transformer, to control load currents considerably greater than its own rating. (This is the same general reduction scheme as the one shown in Figure 1 for manual adjustment of the high-tension transformer.) Two such units, each rated at 6 kva, 115 volts, control the two phases of a 115-to-208-volt line which are required for power supply. The manufacturer's specifications call for ± 0.25 per cent accuracy, and 0.1

control panel tended to be rather sluggish in response, too coarsely calibrated for optimum precision, and subject to some thermal drift during long exposures. Therefore, a precision (± 0.25 per cent) voltmeter has been permanently connected across the high-tension primary as the principal standard of reference. Because radiation output is relatively much less sensitive to variations in tube current, the General Electric electronic filament control and milliammeter have been found satisfactory since correction of an early maladjustment previously reported (3).

The Van de Graaff accelerator was originally built to special order for industrial radiography. Although of comparable basic design, it is a great deal larger and more heavily constructed than the currently manufactured therapeutic models, and in consequence lacks their positional flexibility. Either a radial field distribution similar to that previously described for the Maxitron (3) or a vertical, axially transmitted beam of smaller cross section may be selected. This transmitted beam

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is of particular interest, since at normal (2.0 MEV) operating potential the inherent filtration of 6.35 mm. gold anode plus 4.76 mm. brass water jacket results in an effective half-value layer almost identical to the 11.4 mm. Pb characteristic of Co^{60} . Such a fortuitous coin-

current losses. It is apparent, therefore, that simply regulating the input power line would be relatively ineffective toward the maintenance of uniform radiation intensity. Also, since the kilovolt meter would have to be kept constant to ± 0.25 per cent in order to hold output stability



Fig. 5. Maxitron control table, showing line voltage regulators (lower shelf), external precision meters (front center), and d'Arsonval monitoring galvanometer (upper wall bracket).

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cidence permits very useful comparisons, both physical and biological, between relative effects of the same radiation quality delivered in a single "narrow" beam, or *via* the " 4π " geometry obtainable from the cobalt irradiator to be described below.

Since at 2 MEV the ratio of x-ray output to accelerating potential appears as approximately a fourth power exponential, accurate control of this voltage becomes even more critical than with the other two machines discussed above. Due to inherent characteristics of the electrostatic generator design, however, a number of additional variables are introduced, such as driving motor speed, belt slippage and charging efficiency, corona and leakage

within the desired limits of ± 1.0 per cent, continuous manual adjustment on the basis of voltage readings alone becomes excessively fatiguing to the operator's eyes and nerves, thereby further increasing the possibility of human error. It seems essential, therefore, that a device capable of accurately indicating some quantity *linearly* related to the radiation output, rather than to its fourth root, be used. Since previous experiments (2) had shown that the commercially available monitoring instruments employing electronic amplification were generally unable to meet our arbitrarily imposed standards of constancy, an ionization chamber directly connected to a galvanometer circuit (4) was installed. This combination of cham-

ber (fixed in tube head), battery (sufficient voltage to assure over-saturation during nominal shelf life) and galvanometer (d'Arsonval reflecting type readable within ± 0.5 per cent at distances up to several feet, and maintaining initially calibrated sensitivity through an indefinite number

at approximately 50 r/minute (Fig. 7A) or 9×30 inches at approximately 500 r/minute (Fig. 7B), may be utilized. Phantom measurements of mid-line to skin dose ratios approaching 100 per cent indicate that this "4 π " geometrical configuration closely approximates the theo-

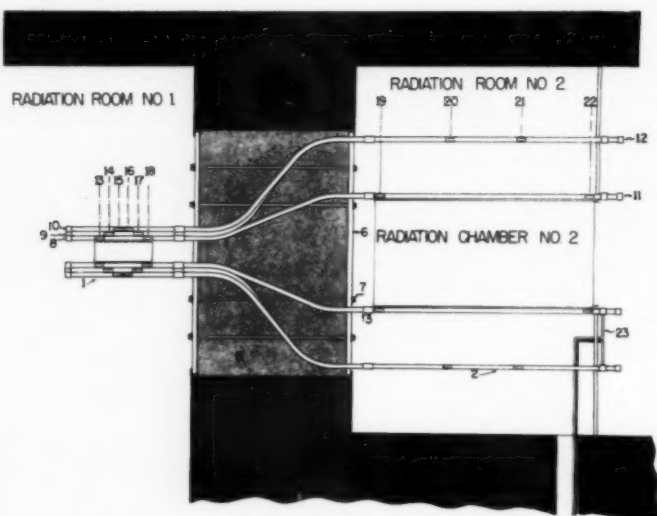


Fig. 6. Sectional view of pneumatic tube transfer system; cobalt irradiator.

of years) provides a reference point for all control adjustments. Thus, in the usual exposure routine, tube potential and current are brought up to approximately normal values; the operator then transfers his principal attention to the output galvanometer and is thereby able to duplicate a prescribed dose within very narrow limits.

Another type of electronic monitoring device, supplied by the High Voltage Engineering Corporation, Cambridge, Mass., is now under test and shows promise of satisfactory stability.

The *cobalt irradiator* consists essentially of 60 individual 25- to 50-curie sources, which can be so positioned as to simulate the gamma flux inside a spherical shell of uniformly distributed radioactivity. By pneumatic transfer between the two rooms indicated in Figure 6, either of two cylindrical exposure chambers, 34×72 inches

retical concept of uniform total-body irradiation, even for animals up to about 300 pounds in weight.

A detailed report of design and performance characteristics from this laboratory will appear later. Meanwhile, since apart from routine decay corrections of approximately 1 per cent each month (and possible human errors in exposure timing) there would seem to be no reason to doubt the absolute reproducibility of exposures, the present discussion will be limited to some special problems of measuring technique.

Dosimetric Procedures: The Victoreen condenser meter continues to serve as the principal base of reference for dose measurements in this laboratory. Through a regular schedule of rotation, each of several such instruments with its associated chambers is recalibrated by the National Bureau of Standards at least once a year. Since

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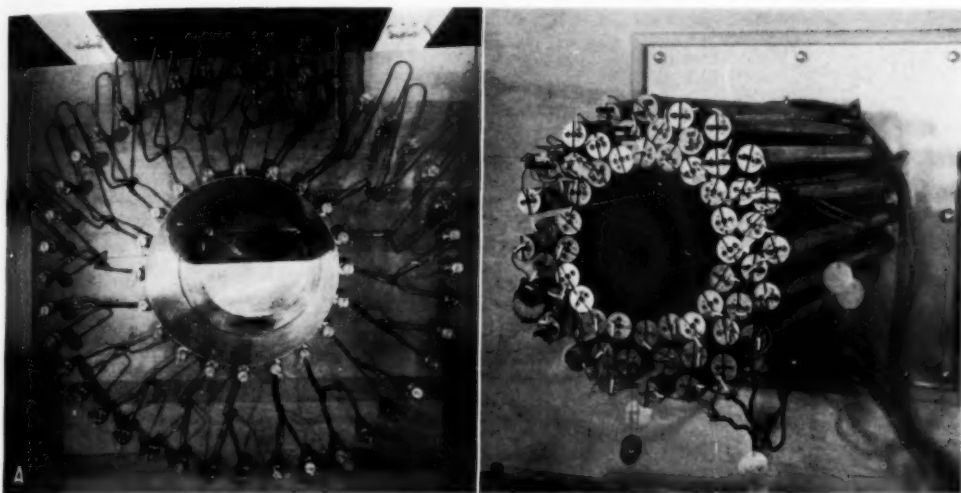


Fig. 7. A. Cylindrical exposure chamber of cobalt irradiator, 34 \times 72 inches. B. Smaller high-intensity exposure cylinder of cobalt irradiator (9 \times 30 inches), partially disassembled.

the stipulated accuracy of N.B.S. thimble chamber calibrations is 3 per cent (although their observed interagreement has nearly always been much better), and because certain long-term experiments are sensitive to smaller dosimetric inconsistencies, a minimum of two chambers are used with each of two different electrometers for cross-comparison in all critical dose measurements.

It has been pointed out (4) that radiation breakdown of insulation resistance and consequent post-exposure leakage of condenser-type chambers constitute an increasing source of error with higher photon energies. For this reason, a continuous reading galvanometer circuit, pre-calibrated against the condenser chambers at moderate x-ray voltages, is preferred for measurements above 200 to 300 kev. The Victoreen Model 510 Ratemeter has also been found quite convenient but, since its electronic amplifier cannot be expected to have the absolute long-term constancy of a d'Arsonval galvanometer, additional care and frequency of cross-comparison with the condenser chambers are indicated.

A dosimetric problem apparently peculiar to the cobalt irradiator is demon-

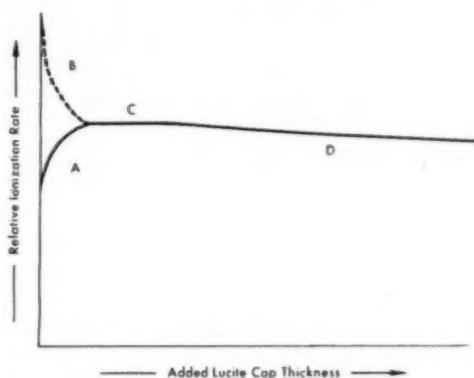


Fig. 8. Electronic equilibrium curve for thimble chambers in the cobalt irradiator.

strated graphically in Figure 8. For all our high-energy measurements with thimble chambers, electronic equilibrium curves of intensity *versus* thickness of added Lucite caps are run as a precautionary measure. With cobalt-60 gamma rays in free air, such curves assume the familiar shape of ACD, rising by several per cent to a relatively flat plateau in the vicinity of C (at approximately 4 mm.), then falling off gradually as absorption becomes significant. In this irradiator, however, a considerable component of very soft scattered gamma rays and/or electrons causes

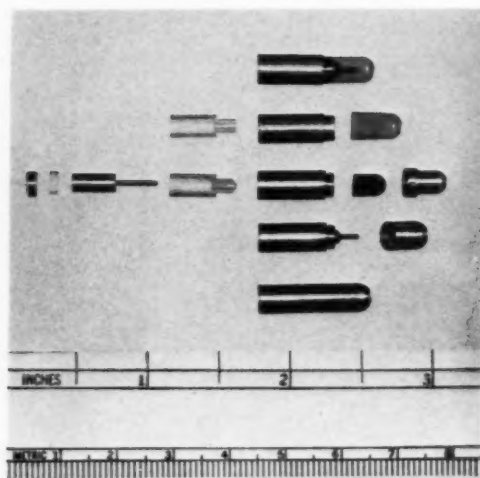


Fig. 9. Miniature ionization chambers and components.

the reversal of initial slope indicated by the dotted line BC. Since a definite 4-mm. plateau still exists, it might be argued that this is the correct equilibrium thickness for absolute dose measurements. The question remains, however, whether the biological effectiveness of this soft component can legitimately be assumed to be negligibly small. Quantitatively, the fraction absorbed here is nearly 6 per cent of the total measured intensity, and qualitatively, a beryllium-window grenz-ray tube at 25 kvp gives a close approximation to the initial slope B of the cap-thickness curve.

A special type of miniature ionization chamber which has been found to be most useful for depth and isodose measurements is illustrated in Figure 9. This was developed from the original ideas of Sievert (5). Major changes in the interest of mass production have included substitution of "Kel-F" halogenated plastic for amber in the condenser insulation, aluminum alloy for "Elektron metal" in the body, and "Markite" conducting plastic for carbon in the cap lining. Plastic-lined metal caps shown in the blown-up view (middle row of Fig. 9) were in approximate electronic equilibrium for the gamma rays of cobalt 60 and showed very satisfactory

wave-length independence down to the order of 80 kev. Subsequent need for measurements in the low-energy region led to modifications shown at the top of Figure 9. Here we have substituted a hardened gelatin cap, sized to a push fit on the chamber body, and at its minimum wall thickness of 5-6 mg./cm.² have obtained satisfactory performance with x-rays down to about 8 kev and betas to 0.2 MEV. The primary advantage of chambers of

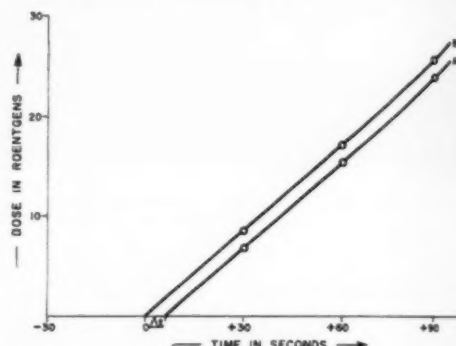


Fig. 10. Time-extrapolated calibration curves.

this type is the small size. Since they cause little disturbance of the effective atomic number within a phantom, and at reasonably high radiation energies exert negligible shadowing effect on one another, as many as 250 have been used simultaneously in one man-sized phantom to obtain a complete three-dimensional depth-dose analysis at a single exposure. Furthermore, possibly due in part to the electronic stability of Kel-F, and perhaps in part to the relatively small cross section of insulating material used, post-exposure leakage errors appear to be greatly reduced. By proper selective choice of charging voltage and electrometer sensitivity, full scale ranges between 35 and 750 r are readily available with the same chambers.

Finally, some sources of timing errors frequently encountered are suggested for consideration. In case of the *Pickar 220* unit, a motor-driven shutter opens and closes in a somewhat erratic cycle of approximately 1.5 seconds, which in turn is seriously influenced by line voltage, age,

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state of lubrication, etc. In case of the *Maxitron* and the *Van de Graaff*, which are not equipped with shutters, the necessary high-tension build-up delay presents an even greater problem. It has therefore been found expedient to employ, in place of the usual mean of several equally timed readings, an extrapolation technic as illustrated in Figure 10. Curve A shows an arbitrary plot of measurements which, extrapolated to zero, would intersect the time axis at a negative value of approximately six seconds. It is therefore concluded that a six-second compensatory additive to the mechanical timer setting is required, and the subsequent curve B, which exactly intersects at 0, 0, fully confirms this opinion.

SUMMARY

Some special physical problems and technics involved in the measurement and delivery of precisely standardized doses of x- and gamma radiation are discussed. The fact that a higher order of dosimetric accuracy is essential for radiobiological laboratory experiments than for routine clinical therapy is emphasized. Difficulties in extending application of the roent-

gen unit to higher photon energies, some mechanical and electrical inadequacies found in commercial x-ray and dosimetric equipment, and improvements obtained by the use of relatively simple accessories are reported. Special reference is made to the unusual problems encountered in operating a 2,400-curie cobalt 60 irradiator of "spherical" configuration.

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SUMARIO

La Dosimetría de la Radiación en la Investigación Biológica

Discútense algunos problemas y técnicas especiales de orden físico que figuran en la medición y entrega de dosis normalizadas precisamente de rayos X y gamma. Recálcase el hecho de que, para experimentos radiobiológicos de laboratorio, resulta indispensable un orden más elevado de exactitud dosimétrica que para la terapéutica clínica corriente. Expónense las dificultades encontradas al extender la aplicación de

la unidad roentgenológica a energías más altas en fotones, algunas insuficiencias mecánicas y eléctricas observadas en el equipo comercial de rayos X y dosimetría y las notables mejoras obtenidas con el uso de accesorios relativamente sencillos. Se hace mención en particular de los inusitados problemas encontrados en el funcionamiento de un irradiador de cobalto 60 de 2,400 curies, de configuración "esférica."

DISCUSSION

Friedrich Ellinger, M.D. (Naval Medical Research Institute, Bethesda, Md.): The splendid collaboration enjoyed by all of us engaged in radiobiological work at the Naval Medical Research Institute is evident in Dr. Morgan's paper. As a

result we have been able to furnish data on the reproducibility of the lethal effect of total-body irradiation in mice, which it was my privilege and pleasure to present before this Society two years ago. At that time we could not go into the details of the dosimetric

aspects of our investigations which Commander Morgan presented to you today. I should like to say that we—the biologists—are not the exclusive beneficiaries of this collaboration. Fortunately, we are able to repay part of our debt, and I should like to illustrate this briefly.

In any institution, some cleaning is going on all the time and our Institute is no exception. On such an occasion one of our good sailors handled a sensitive dosimeter a little too roughly. This was not noticed until after some of the animals were exposed and, during the observation of the mortality rate, it became apparent that something must have been wrong with the dosimetry. We started rechecking and, by comparing our dosimeter with others, found

that the instrument was out of order. With the use of this one instrument only, the change could not be discovered but the inaccuracy became apparent on the basis of our biological observations. After discovery of the discrepancy in the dosimeter readings, all the exposures performed on this and subsequent days could be corrected.

In another instance, when we had been able to indicate to the physicists that something must have been wrong with dosimetry, it was found that the cause was a slowly developing leakage in one of the cables of the x-ray generator. Since we had noted carefully the time of exposure for each batch of animals, we were able to tell the physicists that exactly when the leakage had occurred.



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Portable Shield for Radiation Protection During Angiography¹

JOSEPH STEIN, M.D.,² MAXWELL H. POPPEL, M.D.,³
ERICH G. KRUEGER, M.D.,⁴ and STANLEY MALSKY, M.A., M.Sc.⁵

THE TOTAL RADIATION dose received by the operator during an angiographic examination has been appreciably reduced by the use of a portable shield containing three sections of lead-impregnated rubber. The center section, mounted on a rotating drum so that necessary adjustments in height for each patient can be obtained, is maneuverable up and down, is self-retaining, and contains a square lead-glass section so that the operator can observe the patient and at the same time be protected from excessive radiation.

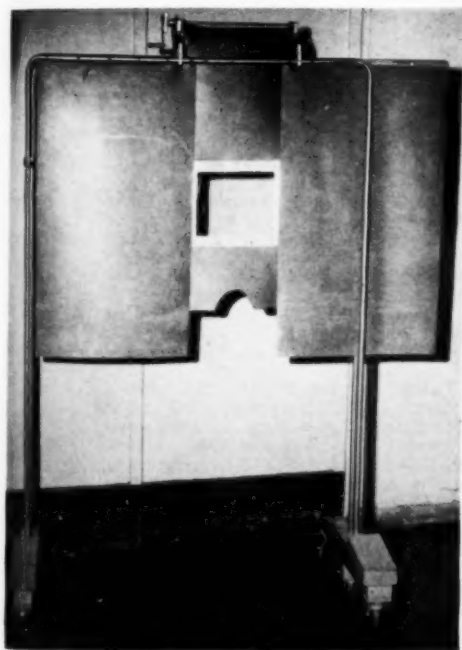
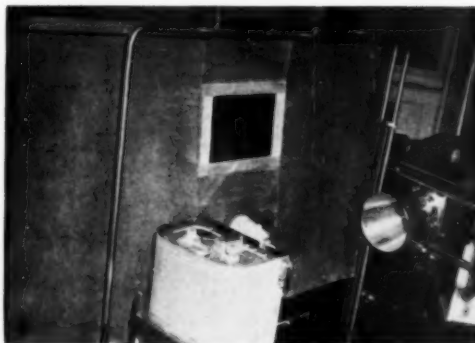


Fig. 1. Assembled shield. The middle section contains lead glass, is self-retaining, and maneuverable up and down.



Figs. 2 and 3. The patient's head is shown against the Fairchild camera, with the x-ray tube in position for lateral (Fig. 2) and anteroposterior (Fig. 3) projections of the skull during angiography.

This new protective unit, when used to supplement the lead apron worn by an operator, will enable him to have ready access to the patient and at the same time receive only a minimal amount of scattered radiation. It thus offers advantages over conventional portable lead-lined shields, which have distinct limitations in respect to flexibility, degree of freedom, and hazards of over-dosage to exposed portions

¹ From the Radiological and Neurosurgical Services, Veterans Administration Hospital, Bronx, N. Y., and New York University College of Medicine. Accepted for publication in May 1955.

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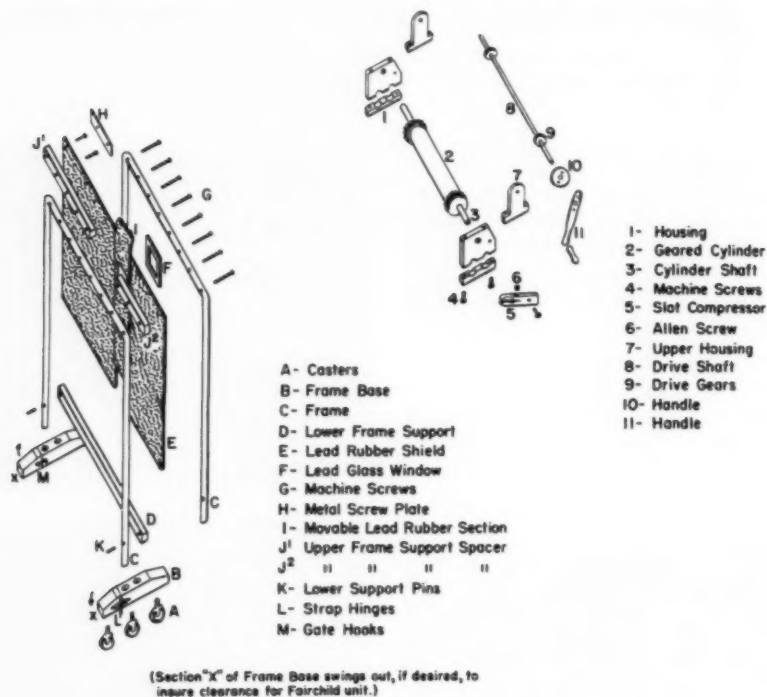


Fig. 4. Construction of the shield. A. Casters, 3 in. diameter, rubber. B. Frame base, 24 in. long, 3 in. wide, 3 in. deep. C. Frame 57 1/2 in. high, 42 in. wide, 3/4 in. round tubing. D. Lower frame support, 1 1/4-in. square tubing, 44 in. long. E. Lead-rubber shield, 20 in. long, 35 in. wide, 1/4 in. thick. F. Lead-glass window, 10 1/2 × 9 in. G. Machine screws, 1 1/4 in. (10 × 24 standard thread). H. Metal screw plate, 10 in. long, 1.8 × 5/8 (standard). I. Movable lead-rubber section, 41 in. long, 12 1/2 in. wide, 1/4 in. thick. J'. Upper frame support spacer, 11/4-in. square tubing, 17 1/2 in. long. J". Upper frame support spacer, 11/4-in. square tubing, 16 1/2 in. long. K. Lower support pins, 1/4 in. diameter, 3 1/2 in. long. L. Strap hinges, 6 in. long, 2 in. wide. M. Gate hooks, 2 1/2 in. (standard).

1. Housing, 1/2 × 3 1/2 × 4 1/2 in. 2. Geared cylinder, 3 1/2 × 12 1/2 in. 3. Cylinder shaft, 5/16 in. diameter, 14 3/4 in. long. 4. Machine screws, 1/4 in. × 20 (standard thread). 5. Slot compressor, 5/16 × 5/8 in., 3 1/2 in. long. 6. Allen screw, 8/32 in. (standard). 7. Upper housing, 1/2 in. deep, 1 3/4 in. long, 2 in. wide. 8. Drive shaft, 5/16 in. diameter, 16 1/4 in. long. 9. Drive gears, 1/8 × 3/4-in. spur gear (standard). 10. Handle, 1/2 in. wide, 2 in. diameter. 11. Handle, 1/4 in. deep, 1 in. wide, 4 1/4 in. long.

(hands, head, etc.) in so far as the operator is concerned (N. B. S. *Handbooks* 41 and 47).

The total dose received by the operator with use of the protective shield is a small fraction of that received with only a lead apron. For the complete examination, when the lead apron affords the only protection, the total dose has been measured as 109 milliroentgens against 10 milliroentgens with both shield and apron.

ACKNOWLEDGMENTS. We are greatly indebted to Miss Ruth Hammerschlag, Chief X-ray Technician, and Mr. James Douglas, Supervising X-ray Technician, for coordinating construction of the shield, to Mr. Cyprian B. Reid, B.Sc., for assistance in calibration and dosimeter measurements, to Mr. Al Alonzo and Mr. L. Maddalone, Machine Shop Technicians, for revising the equipment to suit our purpose, and to the Medical Illustration Department of the Veterans Hospital, Bronx, for their meticulous photographic work.

Veterans Administration Hospital
Bronx, N. Y.

SUMARIO

Pantalla Portátil de Fácil Maniobrabilidad para Protección contra la Radiación Durante la Angiografía

Se describe aquí una pantalla portátil para uso en la angiografía. Consta de tres secciones de caucho impregnado con plomo. La sección central, montada en un tambor rotatorio a fin de poder obtener los necesarios ajustes de elevación para cada enfermo, es maniobrable para arriba y abajo, autorretentora, y contiene una

sección cuadrada de vidrio emplomado, a fin de que el operador pueda observar al enfermo, estando a la vez protegido contra la radiación excesiva. La dosis total recibida por el operador mientras usa la pantalla protectora es una pequeña fracción de la recibida cuando sólo usa un delantal de plomo.



EDITORIAL

On Vascular Nevi

Editorial Note: The choice between two courses is not always an easy matter, especially perhaps between a course of action and one of relative inaction. Even the most expert may find themselves at odds. Under such circumstances, the best that the medical journalist can do is to present the diverse points of view as a basis for judgment. In this issue of RADIOLOGY will be found a paper by two Danish radiologists reporting the favorable results of ultrasoft roentgen rays in the treatment of hemangiomas. Following is an Editorial, written entirely independently, reaching quite different conclusions. Both are commended to the attention of our readers.

"We are fain to borrow other Men's Eyes" observed Thomas Browne long years ago. A look at the radiologic literature over the years dealing with the management of vascular nevi, however, would cause one to wonder if this be always true, or if for that matter sometimes we are ever willing to give our own eyes a chance. Perhaps it is just that the management of vascular nevi occurring in today's and recent yesterday's children is so often a facultative scotoma.

In the considerable welter of articles appearing in the English radiologic literature, abstracts as well as originals, scarce any but deal with how to do something to the poor innocent who happens to have in addition to a vascular birthmark a distraught parent and sometimes, to complicate matters, a medical advisor of the "we must do something now" type. That this common birthmark is in most instances a passing thing having a well defined period of growth, more or less rapid, and then spontaneously regressing is rarely mentioned and, rarer still, advocated. The natural history of the lesion is all but neglected and forgotten, and what nature does is often mistaken for the result of the physician's effort. Judging

by this literature, it would seem that among the radiologists it is common belief that active and immediate treatment is imperative.

Accordingly today's youngsters seem to stand little chance of escaping treatment of some kind. True, under the pressure of an anxious parent and in the face of an often uncritical literature, it sometimes is difficult to follow a policy of expectancy. Consequently, if we are not willing to learn for ourselves what happens in the natural course of events, we must perforce use other men's eyes. For this reason, attention to several pertinent articles dealing with what happens to vascular nevi when nature is relied upon is invited.

The classic article, easily available, to which even the therapeutic strong men give a nod of obeisance is that of W. A. Lister (1) wherein is recorded the result of careful observation of a group of children with some 93 strawberry nevi. Of these 93 birthmarks, found in 17 boys and 60 girls, 92 regressed and disappeared without any treatment whatsoever. Lister observed that most strawberry nevi stopped growing by the time the child was eight months of age and none continued to grow after the first year (Paterson says eighteen months), and that the more rapid the earlier growth, the more rapid the regression. No untoward occurrence followed the policy of watchful waiting and he concluded that "no exception has been found to the rule that nevi which grow rapidly during the earlier months of life subsequently regress and disappear of their own accord on the average at the end of the fifth year of life."

An uncommonly sensible paper by J. Walter (2) appeared in October 1953.

L In an attempt to assess Lister's thesis, this author deliberately withheld treatment of capillary and cavernous hemangiomas in children, observing them only, and then compared the results with those obtained by his colleagues who treated all such lesions by radiotherapy. Though it is true that in the first year of observation, or in the treated cases in the first year after therapy, the satisfactory results in the treated group were almost twice those of the untreated group (9 per cent as compared to 4.8 per cent), at the end of the second year there was no difference in the occurrence of satisfactory regression in the two groups (28 and 27 per cent). This state of affairs continued parallel until the end of five years, when both those actively treated by the radiotherapist and those left to the good devices of nature and a willing and careful observer, showed satisfactory healing in almost all instances and in like frequency, 94 and 96 per cent respectively. The conclusion is inescapable.

A more recent observation of still another author (3) who had the courage to see what nature would do records failure to regress spontaneously in only 1 of 41 instances, albeit 6 did show ulceration, which healed without serious result. Modlin points out that, while ideal treatment would perhaps be excision or some other form of immediate destruction of the lesion while it is still tiny and before rapid growth begins, relatively few babies are seen at this age by a physician; it is only later, when rapid growth is well under way, that the parent becomes alarmed and the physician is called. By this time, the nevus is too extensive for simple excision and the risk of deformity by local destruction too great; the best cosmetic result to be obtained in most instances is by giving Nature a chance.

Thus it would seem that the really alarming thing about vascular nevi is not the policy of "wait and see," but the fact that so few are willing to give credence to the observation of others and so allow Nature a reasonable place in the plan of management.

True, it is equally wrong to say that no vascular nevi should ever be treated by radiation and on this presumption send the small child away without further attention. There are some nevi which may very well be immediately destroyed or in which healing may be accelerated to advantage, but these are a small minority. All nevi need careful and thoughtful follow-up observation.

Increased risk of deformity, infection and ulceration, of irretrievably persistent growths, or of malignant transformation, which gives some writers so much concern, seems to be overstated. In no instance was any such occurrence recorded by any of the observers above cited and there is no such authenticated case known by this writer.

Port-wine stains, nevus flammeus, are perhaps not true vascular nevi in the ordinary sense of the word. They are entirely refractory to radiotherapy or to any other form of management short of actual destruction, and there are few who really advocate active treatment in these. The somewhat similar appearing bluish discoloration occurring at the nape of the neck and over the forehead of the newborn, the so-called stork-bite, occasionally mistaken for a port-wine stain, invariably disappears by itself and, in fact, usually has done so by the time the doctor becomes disturbed. Spider nevi are promptly destroyed by occlusion of the central feeder, usually by spark or injection, which leaves no appreciable scar. With this there is general agreement.

It is in the care of the superficial capillary strawberry nevi and deeper vascular or cavernous and mixed hemangiomas that controversy still exists. If these are seen in their incipiency and simple excision or immediate destruction by cautery or injection can cause prompt regression of the whole without cosmetic difficulty and before any appreciable size has been attained, this may be done promptly. Usually, however, the time for this form of treatment has passed when the child is first seen and the period of active growth

is well advanced. Management of all other lesions will then consist principally in reassurance of the parent and careful periodic observation of the child, active treatment, by any of the widely recorded tried and safe methods, being reserved for those lesions which by their position and continued growth present risk of infection or of deformity. Almost invariably growth will cease in the first year and spontaneous regression will be complete between the third and fifth year of life, often before, and with an entirely satisfactory cosmetic result; in lesions with a cavernous component perhaps a little more reluctantly than in those of purely strawberry character.

There are apparently rare nevi which do continue to enlarge beyond the first or second year. In these, conservatism might well give way to more active treatment. Then too there are those hemangiomas, usually of the deeper cavernous type, which do not have their inception in infancy but develop later in life. These also demand active treatment.

In following a policy of conservatism, the writer has never seen any of the misfortunes conjured up by some. This experience, shared by others, causes one to wonder if it might not be well if a little

less haste were observed in the application of active treatment to superficial strawberry and deeper cavernous vascular birthmarks. Radiologists should be not unduly influenced by the volume of literature suggesting that the policy of immediately "doing something" about vascular nevi is in all instances the most desirable one. They should give careful thought to what has really been accomplished. They should reflect on the fact that rarely is a vascular nevus or an unsightly sequel to one noted on the skin of contemporaries or those who were infants before the gifts of Roentgen and the Curies could be pressed upon them. Radiologists may well recall the dicta so often displayed in our medical institutions—"primum non nocere" and "Naturam sequere"—and also recall that when Nature does a thing she often does it better if left unmolested.

MILFORD D. SCHULZ, M.D.
Massachusetts General Hospital

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ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN RADIUM SOCIETY

At the Thirty-eighth Annual Meeting of the American Radium Society in Houston, Texas, April 9-11, the following officers were elected: President, Norman A. McCormick, M.D., Windsor, Ont., Canada; President-Elect, Douglas J. Roberts, M.D., Hartford, Conn.; First Vice-President, Franklin L. Payne, M.D., Philadelphia, Penna.; Second Vice-President, George W. Waterman, M.D., Providence, R. I.; Secretary, Theodore R. Miller, M.D., 139 E. 36 St., New York 16, N. Y.; Treasurer, Jesshill Love, M.D., Louisville, Ky. Dr. Charles L. Martin, of Dallas, Texas, was named representative of the Society on the Board of Chancellors of the American College of Radiology.

The next Annual Meeting will be held in the Chateau Frontenac, Quebec, May 30-June 1, 1957.

KANSAS RADIOLOGICAL SOCIETY

At a meeting of the Kansas Radiological Society in Kansas City, Kans., on Feb. 13, the following were re-elected to office: A. M. Cherner, M.D., Hays, President; L. G. Allen, M.D., Kansas City, Kans., Vice-President; G. S. Ripley, Jr., M.D., West Iron Avenue, Salina, Secretary-Treasurer.

TENNESSEE RADIOLOGICAL SOCIETY

The Tennessee Radiological Society, at a meeting held in conjunction with the State Medical Association meeting in Memphis, on April 10, 1956, elected the following officers for the ensuing year: President, Dr. Ben R. Mayes, Nashville; Vice-President, Dr. W. E. Scribner, Kingsport; Secretary-Treasurer, Dr. George K. Henshall, 311 Medical Arts Building, Chattanooga 3. Dr. Herbert C. Francis of Nashville was nominated Councilor to the American College of Radiology for the State of Tennessee and Dr. Walter Hankins, of Johnson City, was named alternate Councilor.

TEXAS RADIOLOGICAL SOCIETY

The next meeting of the Texas Radiological Society will be held at the Driskill Hotel, Corpus Christi, Texas, Jan. 18 and 19, 1957. Arrangements have been made for a conducted tour of the fabulous King Ranch near Corpus Christi, for members and guests, on the day preceding the meeting (Jan. 17).

The officers of the Society for the coming year are: Dr. J. R. Riley, Corpus Christi, President; Dr. T. G. Russell, Houston, President Elect; Dr. R. F. Wertz, Amarillo, First Vice-President; Dr. H. C. Sehested, Fort Worth, Second Vice-President; Dr. J. E. Miller, 6407 Forest Lane, Dallas, Secretary-Treasurer; Dr. T. B. Bond, Fort Worth, Historian.

GEORGE W. HOLMES LECTURE NEW ENGLAND ROENTGEN RAY SOCIETY

To deliver the twelfth George W. Holmes Lecture at its annual meeting on May 18, the New England Roentgen Ray Society chose Dr. Laurence L. Robbins, a former pupil of Dr. Holmes and his successor as Chief of the Department of Radiology of Massachusetts General Hospital. The subject of Dr. Robbins' lecture was "The Radiologist Faces Automation." As a permanent reminder of the signal honor conferred upon him, Dr. Robbins was presented with a silver "Paul Revere" pitcher.

This lectureship was established in 1945 in honor of Dr. Holmes, who was himself the first lecturer.

EIGHTH INTERNATIONAL CONGRESS AN INVITATION

The Los Angeles Radiological Society extends a cordial invitation to foreign radiologists and their families to visit Los Angeles following the International Congress of Radiology in Mexico. Between July 30 and Aug. 2, the Society will arrange for sight-seeing tours, visits to motion picture studios, visits to radiological installations in hospitals and private offices, entertainment in the homes of radiologists in Los Angeles, etc. Hotel accommodations in Los Angeles may be obtained through any travel agency.

For further information address Dr. Stefan P. Wilk, University of California Medical Center, Los Angeles 24, Calif.

ROSS GOLDEN, M.D.
Chairman, Reception Committee

AMERICAN SOCIETY OF X-RAY TECHNICIANS

The American Society of X-Ray Technicians will hold its annual convention in the Kentucky Hotel, Louisville, Ky., June 17-21. In addition to a carefully planned program, a Refresher Course is offered from 8:00 to 11:45 A.M., Monday through Thursday, and a Workshop from 9:00 A.M. to 5:45 P.M. on Saturday. Educational exhibits and numerous entertainment features will add to the interest of the meeting.

ATOMS FOR PEACE AWARDS

Final details of the organization of Atoms for Peace Awards, Inc., were recently announced by Dr. James R. Killian, Jr., President of the Massachusetts Institute of Technology. The awards are made possible by an appropriation of the Ford Motor Company as a memorial to the late Henry Ford and his son, Edsel Ford.

According to the Certificate of Incorporation of the new organization, of which Dr. Killian is President, "The recipient of the Atoms for Peace Award will be determined each year by the Trustees, who will select from among the world's scientists, engineers, or others, the individual, group of individuals, or organization who in their judgment has made the greatest contribution to the peaceful uses of atomic energy. The decision of the Trustees will be made solely on the basis of the merit of the contribution, wherever found in the world.

"The Award is to consist of a cash honorarium accompanied by a suitable medal, to be designed and cast for the purpose. If the Board of Trustees should fail to discover a candidate preeminently meriting the Award in any year, the Award and medal may be withheld during that year. In that event the Trustees may hold the funds available for additional awards in future years or dispose of that year's funds by grants in the United States of America to advance the science or technology relating to the uses of atomic energy for peaceful purposes."

ERRATA

Attention is called to an unfortunate error in a paper on "Recurrent Carcinoma of the Colon at the Site of Anastomosis" by Felix G. Fleischner and Arnold L. Berenberg, in the April 1956 issue of *RADIOLOGY*. On page 547, in the fourth line of the Addendum, the word *carcinoid* should be substituted for *carcinoma*.

In the same issue of *RADIOLOGY*, in a paper by Sherman and Soong on "Ewing's Sarcoma," in line 12 under the heading Differential Diagnosis, page 538, the word *epiphyseal* should be changed to *diaphyseal*. The sentence will then read: "All other radiological types, with the exception of the cortical diaphyseal lesions, which are quite suggestive of Ewing's sarcoma, offer greater difficulties in differential diagnosis. . . ."

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ANKYLOSING SPONDYLITIS. CLINICAL CONSIDERATIONS, ROENTGENOLOGY, PATHOLOGIC ANATOMY, TREATMENT. By J. FORESTIER, M.D., F.A.C.R. (Hon.), Aix-les-Bains, F. JACQUELINE, M.D., Aix-les-Bains, and J. ROTES-QUEROL, M.D., Barcelona. Translated by A. U. DESJARDINS, M.S., F.A.C.P., F.A.C.R. A volume of 374 pages, with 145 figures. Published by Charles C Thomas, Springfield, Ill., 1956. Price \$10.75.

RADIUM THERAPY. ITS PHYSICAL ASPECTS AND EXTENSIONS WITH RADIOACTIVE ISOTOPES. By C. W. WILSON, M.Sc., Ph.D., F.Inst.P., Principal Physicist to the Westminster Hospital, London. Foreword by Sir Stanford Cade, K.B.E., C.B., D.Sc., F.R.C.S., M.R.C.P., F.F.R. A volume of 286 pages, with 73 text figures, and 21 plates. Published by Baillière Tindall and Cox, London; The Williams & Wilkins Co., Baltimore. Second ed., 1956. Price \$7.50.

ÉTUDE RADIO-ANATOMIQUE DE L'OS TEMPORAL. By M. JUSTER, Chargé de Recherches au C.N.R.S., and H. FISCHGOLD, Electroradiologiste des Hôpitaux de Paris, with the technical collaboration of G. KORACH. A volume of 106 pages, with 51 figures. Published by Masson et Cie, 120, Boulevard Saint-Germain, Paris 6°, 1955. Price 2,000 fr. (paper bound), 2,800 fr. (cloth).

LE CANCER DU PLANCHER DE LA BOUCHE. By MARCEL DARGENT, Professeur Agrégé à la Faculté de Médecine de Lyon, Chirurgien des Hôpitaux, Chef du Service de Chirurgie du Centre Anticancéreux de Lyon, and JEAN PAPILLON, Radiologiste des Hôpitaux, Chef du Service de Radiothérapie du Centre Anticancéreux de Lyon. With the collaboration of J.-F. MONTBARBON, Assistant de Radiothérapie du Centre Anticancéreux de Lyon. Preface by P. Santy. A volume of 170 pages, with 48 figures. Published by Masson et Cie, 120, Boulevard Saint-Germain, Paris 6°, 1955. Price 1,800 fr.

UROLOGIE DE L'ENFANCE. TRAVAIL DE LA CLINIQUE MÉDICALE DES ENFANTS DE LA FACULTÉ DE PARIS (Professor Robert Debré). By GASTON LAURET, Ancien Interne des Hôpitaux de Paris, chargé de la consultation d'urologie à la Clinique Médicale des Enfants Malades, and Collaborators. Preface by Professor Debré. A volume of 442 pages, with 330 figures. Published by Expansion Scientifique Française, 15, Rue Saint-Benoît, Paris 6°, 1956. Price 3,900 fr.

TUBERCULOSE UTÉRO-ANNEXIELLE. ASPECTS ACTUELS—DIAGNOSTIC—TRAITEMENT. By JULES BRET, Gynécologue-Accoucheur des Hôpitaux de Paris, and ROBERT LEGROS, Gynécologue-Accoucheur adjoint de l'Hôpital de Créteil, with the collaboration, for pathologic anatomy, of BERNARD DUPERRAT, Médecin des Hôpitaux de Paris. Professeur agrégé à la Faculté de Médecine de Paris. A volume of 248 pages, with 60 figures. Published by Masson et Cie, 120, Boulevard Saint-Germain, Paris 6°, 1956. Price 1,600 fr.

L'ANGIOGRAPHIE VERTÉBRALE. By PIERRE NAMIN, Chef de Clinique de la Faculté de Médecine de Paris. A monograph of 110 pages, with 40

photographs and 27 diagrammatic drawings. Published by G. Doin & Cie, 8, Place de L'Odéon, Paris 6°, 1955. Price 1,800 fr.

LES FONDEMENTS ANATOMO-RADIOLOGIQUES DE L'INVESTIGATION PULMONAIRE. By F. KOVÁTS, JUN., Médecin chef de l'Institut d'exploration de la tuberculose de Budapest, and Z. ZSEBOK, Docent à la 2^e Clinique chirurgicale universitaire de Budapest. Translated from the 3d German edition. Preface by Doctor A. Courcoux de l'Académie Nationale de Médecine. A volume of 336 pages, with 352 figures including many in color. Published by Masson et Cie, 120, Boulevard Saint-Germain, Paris 6°, 1955. Price 8,000 fr. (Original German edition reviewed in *Radiology* 63: 432, 1954.)

MICRORADIOGRAFIA OSSEA. SVILUPPO ACCRESCIMENTO DELLO SCHELETRO UMANO. CRANIO E COLONNA VERTEBRALE. By DOTT. GIORGIO PREVEDI, AIUTO DI RUOLO, and DOTT. MARCO MARCATO, Assistente Straordinario, Istituto di Radiologia e del Radium dell'Università e degli Ospedali Riuniti di Parma, and Istituto di Anatomia Normale dell'Università di Parma. A monograph of 144 pages, with 70 figures. Published by L. Cappelli, Bologna, 1955.

Book Reviews

THE YEAR BOOK OF RADIOLOGY (1955-1956 YEAR BOOK SERIES). RADIOLOGIC DIAGNOSIS, edited by JOHN FLOYD HOLT, M.D., Professor, Department of Radiology, University of Michigan, and FRED JENNER HODGES, M.D., Professor and Chairman, Department of Radiology, University of Michigan. RADIATION THERAPY, edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and MORTON M. KLIGERMAN, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Assistant Radiologist, Presbyterian Hospital, New York City. A volume of 414 pages, with 344 figures. Published by the Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Ill. Price \$9.00.

The *Yearbook of Radiology* (1955-1956 Series) continues to present, in the form of comprehensive abstracts from the world literature, a well balanced review of progress in the specialty during the period covered (June 1954-June 1955). The introductory pages preceding the sections on Diagnosis and Therapy are excellent summaries of achievements in these fields and the potentialities for the future. Thus, Drs. Holt and Hodges point to the fundamental technical advances now in course of develop-

ment, mentioning among others image amplification, the mechanization of film processing, diagnostic applications of isotopes, and newer aspects of roentgen cinematography and tomography. They offer, as usual, a good selection of material on the various organ systems.

Introducing the therapeutic section, Drs. Jacox and Kligerman mention three subjects that have received outstanding attention: (a) clinical and experimental uses of radioisotopes; (b) radiobiologic animal experiments on the effects of total-body irradiation and methods of protection; (c) physics, dosimetry, and treatment technics. They have chosen, wisely, to abstract papers differing from material in previous *Yearbooks*.

In both sections of the work editorial notes add interest and value to the well chosen abstracts.

SEGMENTAL ANATOMY OF THE LUNGS. A STUDY OF THE PATTERNS OF THE SEGMENTAL BRONCHI AND RELATED PULMONARY VESSELS. By EDWARD A. BOYDEN, Ph.D. (Med. Sc.), Professor Emeritus of Anatomy, The Medical School, University of Minnesota. A volume of 276 pages, with numerous illustrations in black and white and color, including schematic drawings, sketches, and tables. Published by The Blakiston Division, McGraw-Hill Book Company, Inc., New York, 1955. Price \$15.00.

The method of presentation employed in this comprehensive work will be familiar to readers of *RADIOLOGY*, which has had the privilege of publishing two of Professor Boyden's studies on segmental anatomy of the lungs. The material is based upon developmental considerations in the formation of the lungs from the lung buds. Each lobe is described in detail, with reference to its vascular and bronchial formations and characteristics, a numerical system being employed in which corresponding arteries, veins, and bronchi are designated by the same number. The investigation was made by means of gross dissection and radiographic study of injected specimens.

Developmental variations and congenital anomalies are discussed in a separate chapter. Emphasis is placed upon minor variations, and their frequency of occurrence is detailed throughout. The illustrative material is excellent and includes many color plates.

Because of the fullness of detail, the work would appear to be of greatest value to thoracic surgeons, although radiologists will also find it useful for an understanding of abnormally placed structures and anomalies encountered on bronchography. Eventually, with greater use of angiography, the finer points of the pulmonary circulation will also demand increased attention from the radiologist.

ANNUAL REPORT ON THE RESULTS OF TREATMENT IN CARCINOMA OF THE UTERUS. (Previously:

Annual Report on the Results of Radiotherapy in Carcinoma of the Uterine Cervix). Volume 10. Statements of Results Obtained in 1948 and Previous Years (Collated in 1954). Sponsored by American Cancer Society; British Empire Cancer Campaign; Cancerföreningen, Stockholm; Damon Runyon Memorial Fund, New York; Landsforeningen mot Kreft, Oslo; National Cancer Institute of Canada; Oeuvre National Belge de Lutte contre le Cancer. Editorial Committee, DR. J. HEYMAN (Editor), Stockholm; DR. M. DONALDSON, London; DR. JOE V. MEIGS, Boston; PHIL. DR. C-O SEGERDAHL, Stockholm. A paper-bound volume of 346 pages, Published by P. A. Norstedt & Söner, Stockholm, 1955.

The *Annual Report on the Results of Treatment of Carcinoma of the Uterus*, which appeared originally under the auspices of the Health Organization of the League of Nations and more recently through the collaboration of leading cancer societies, faces an uncertain future. Not only has no permanent organization been effected to assume responsibility for its publication, but the current issue is the last to appear under the editorship of Dr. Heyman, who has been so largely responsible for the *Report* in the past.

The information for the present volume was furnished by eighty-four collaborators, and is presented in two sections, one on carcinoma of the cervix and one on carcinoma of the corpus. Preceding the statistical tables are a number of introductory chapters, which account for the high degree of reliability of the figures presented. One of these is entitled "Avoidable Sources of Error in Therapeutic Cancer Statistics," while others present definitions of the different varieties of carcinoma of the uterus and vagina, definitions of the different clinical stages of the disease, and rules for collaborators.

This *Annual Report* holds a unique place in cancer reporting, and Dr. Heyman's contribution to the cause of better statistics is inestimable. It is to be hoped that the work which he has established upon such a sound basis will be continued without interruption.

LA TOMOGRAPHIE AXIALE TRANSVERSALE. ÉTUDE THÉORIQUE. APPLICATIONS CLINIQUES. By GÉRARD BONTE, Electro-Radiologiste des Hôpitaux de Lille, GÉRARD TRINEZ, Electro-Radiologiste de l'Hôpital d'Amiens, and MICHEL BRENOT, Ingénieur E.B.P. Preface by Professeur Charles Gernez-Rieux, Membre de l'Académie Nationale de Médecine. A monograph of 166 pages, with 135 illustrations. Published by G. Doin et Cie, Éditeurs, 8, Place de l'Odéon Paris 6°, 1955. Price 2,200 fr.

This little atlas-manual is divided into four sections: (1) Principles, Apparatus, and Technic; (2) Geometrical and Experimental Studies; (3) Clinical Applications; (4) An Atlas of the Normal

and Abnormal. Under these headings the authors cover well the theory and practice of a method of radiological examination which has found wide usage on the European continent, especially in Italy and France, but up to now has not "taken" in this country. The shortcomings inherent in the method are evaluated, as are the advantages.

The final section, essentially an atlas, is useful in demonstrating the normal thoracic and upper abdominal anatomy and such abnormal states as pleurisy, pneumothorax, cavitation, tumors, etc.

RÖNTGENAUFNAHMETECHNIK IN DER HALS-NASEN-OHRENHEILKUNDE. By DR. MED. BURKHARD SCHLOSSHAUER, Hamburg. A monograph of 48 pages, with 72 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1956. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 12.—(\$2.85).

This text on roentgenographic technic for ear, nose, and throat examinations, designed to serve the x-ray technician, contains an adequate selection of views to satisfy all needs. Even a chapter on sialography is included. Tomography and roentgenographic magnification are discussed only briefly, as the author believes that positioning for these procedures requires the personal attention of the radiologist.

Clear photographs, line drawings, and roentgenographic reproductions of high quality add much to the usefulness of this practical outline.

In Memoriam

JACOB ABOWITZ, M.D.

1879-1956

Dr. Jacob Abowitz, who for many years had practiced radiology in Los Angeles, died in Dallas, Texas, on Feb. 24, 1956, at the age of seventy-seven. Dr. Abowitz was born in Russia in 1879. He was graduated from the School of Medicine of Fordham University, New York City, in 1917, and early specialized in radiology. He was assistant to the Chief Radiologist in the Post-Graduate Hospital and Associate Professor of Roentgenology in the Post-Graduate Medical School, New York, until 1927, when he moved to Los Angeles. There he served for some twenty years as Chief Radiologist at Cedars of Lebanon Hospital. For a number of years thereafter, until his retirement, he was associated with the City of Hope Hospital in a similar capacity.

Dr. Abowitz was certified by the American Board of Radiology in 1937. He became a member of the Radiological Society of North America in 1936. He held membership also in the American College of Radiology and in state and local medical organizations.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Vertebral Arteriography of the Brain. Detailed Diagram of the Arterial Branches in the Fronto-Occipital Roentgen View. H. F. Plaut. *Am. J. Roentgenol.* **74**: 226-231, August 1955.

The vertebral artery system, as demonstrated by vertebral arteriography of the brain in the lateral and fronto-occipital (Chamberlain-Towne) projections, is described and illustrated schematically. The vertebral arteries are branches of the subclavian of either side. Their system supplies the brain stem, cerebellum, and temporo-occipital lobes. Vertebral arteriography has been advocated for the study of vascular or space-occupying lesions suspected of lying in these areas.

The right and left vertebral arteries unite to form the basilar artery. Shortly before their junction, each gives off a posterior inferior cerebellar artery. The basilar artery follows the bony incline of the clivus forward and upward and gives off the anterior inferior cerebellar arteries (obscured by the massive temporal bones) and the bilateral superior cerebellar arteries before its terminal bifurcation to form the two posterior cerebral arteries. These vessels start just a little above and behind the posterior clinoids.

In the fronto-occipital projection (Chamberlain-Towne) one can compare the vessels of the right and left sides. The author stresses the normal asymmetry of their paths and caliber.

Two schematic drawings.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

The Behaviour of the Pial Vessels During and After the Intracarotid Injection of Roentgen Contrast Media. H. W. Schmidt. *Acta radiol.* **44**: 100-108, August 1955.

Subjective and objective sequelae to cerebral arteriography are said frequently to be related to vascular injury and angiospasm. Previous investigations of vascular changes incident to the employment of contrast media have yielded contradictory results. In an attempt to define the vascular reactions to such materials, the author has carried out an investigation on experimental animals (rabbits and cats). The cerebral vessels were exposed after cranial trepanation and removal of the dura and were observed microscopically before, during, and after the injection of various contrast media in varying concentrations. The widths of the vessels during the different stages were registered by an ocular micrometer and by photographic records. Femoral artery blood pressures were recorded during the experiments.

Only when high percentage solutions were injected was any circulatory disturbance observed. Concentrated solutions retarded the flow in the vessels or even produced temporary arrest of circulation. The injected medium appeared to flow back and forth in the pial arteries. During the time of inactivation of flow of the contrast substance, the vessel lumen enlarged. As the flow started again, there was a slow return to normal caliber. Under no circumstances was angiospasm observed, regardless of the concentration of the medium or the rapidity of the injection. During and after the injection of the contrast media (with the

exception of Thorotrast) the blood pressure fell gradually to approximately one-third its normal value (requiring approximately fifteen seconds). After this interval, there was a gradual rise to a normal level after approximately forty seconds (measured from the start of the injection). Some of the animals exhibited dyspnea and even apnea following the injection of highly concentrated media, and in isolated instances convulsions occurred.

Since (1) no circulatory disturbance was noted following the injections of the contrast media of less concentration, and since (2) vascular disturbances identical with those recorded following injection of concentrated solutions could be duplicated by injection of Periston-Kollidon solutions, the author attributes the responses to physical rather than chemical properties, namely, viscosity. The more viscid the substance, the slower the flow rate and greater the stasis. Stasis followed by temporary circulatory arrest and the resultant anoxia lead to vasodilatation. Ensuing endothelial damage resulting in permeability disturbances, hemorrhage, edema, and changes in the neuroglia and ganglion cells (which have been described as a complication of cerebral angiography) would then be significant in the production of headache, paralysis, and convulsions. In effect, this vascular arrest is similar to a temporary occlusion and physiologic infarction.

Nine roentgenograms. JOHN W. WILSON, M.D.
University of Texas, Dallas

Agenesis of the Corpus Callosum. A Report of Two Cases in Siblings. James Naiman and F. Clarke Fraser. *Arch. Neurol. & Psychiat.* **74**: 182-185, August 1955.

Two cases of complete agenesis of the corpus callosum in siblings are reported. The main clinical features in both cases were severe mental retardation and physical underdevelopment. The diagnosis was based on the characteristic pneumographic findings, notably enlargement of the lateral ventricles, particularly posteriorly.

The occurrence of this anomaly in siblings suggests that it may be of genetic origin.

Four roentgenograms.

Ruptured Intracranial Aneurysm During Pregnancy. Diagnosis and Treatment. Robert L. Feldman, Sidney W. Gross, and Seymour Wimpfheimer. *Am. J. Obst. & Gynec.* **70**: 289-295, August 1955.

The authors report a case of ruptured intracranial aneurysm of the circle of Willis, proved by cerebral angiography, in a 28-year-old white primipara in the eighth month of pregnancy, with recovery following carotid ligation. Only 2 other cases diagnosed by angiography were found in the literature.

The diagnostic and therapeutic procedures in pregnancy do not differ from those in the non-pregnant patient. Unilateral carotid puncture with compression of the opposite carotid artery during injection of the radiopaque medium, with anteroposterior x-ray exposure, will usually provide the desired information. If satisfactory visualization of both sides of the anterior portion of the circle is not obtained by this method, bilateral carotid angiography becomes essential.

The hemodynamic and vascular changes during

pregnancy and labor are associated with an increased incidence of recurrent hemorrhage. It is therefore felt that tubal ligation is warranted in patients with conclusive proof of a previously ruptured aneurysm. Therapeutic termination of pregnancy is held to be justified when the accident occurs early.

It is suggested that many obscure obstetrical deaths may represent undiagnosed ruptured intracranial aneurysms.

One roentgenogram.

R. L. EGAN, M.D.

University of Texas, Houston

Pneumography and Planigraphy of the Retrobulbar Area for Visualization of the Optic Nerve. Antonio Toti. *Radiol. med.* (Milan) 41: 742-758, August 1955. (In Italian)

This study deals with the demonstration of the optic nerve from its entrance into the orbit through the optic foramen to its entrance into the bulb. Air (10-15 c.c.) is introduced into the posterior orbit close to the optic foramen, and films are taken within fifteen to twenty minutes, since the air disappears rather rapidly. Larger amounts, however, offer no advantage. The patient is instructed to keep the eyes immobile. A semiaxial (nasomental) and a Rhese optic foramen view are obtained.

Immediately after taking these two views, the author obtains postero-anterior planigrams with the patient's nose and chin against the table. Sections begin at 5.0 cm. and are made at 2.5 mm. intervals until a depth of 7.5 to 8.0 cm. is reached. The optic vasculonervous bundle is seen as a rounded shadow of the caliber of a pencil and can be studied in its course. The procedure is said to have produced no complications.

A discussion of the anatomy of the orbit is included, and the division into precapsular and retrocapsular spaces is stressed. The capsule of Tenon is the dividing structure. The optic nerve runs through a canal formed by the rectus muscles. The ophthalmic artery and vein are lateral to it, while the oculomotor, nasociliary, and abducens nerves are medial.

Thirty-two illustrations, including 16 roentgenograms.

ALEXANDER R. MARGULIS, M.D.

University of Minnesota

THE CHEST

Carcinoma of the Lung. Fay H. Squire. *J. Iowa M. Soc.* 45: 409-415, August 1955.

In a period of two and a half years there were seen in the Presbyterian Hospital, Chicago, more than 50 patients in whom a tissue diagnosis of primary carcinoma of the lung was made. Twenty of the tumors were resectable. Most of the patients were between fifty and eighty years of age, but a minor concentration of cases fell within the thirty-to-forty-year bracket.

Included among the radiologic procedures which can be used in investigating such lesions are postero-anterior and lateral roentgenography in inspiration and expiration, fluoroscopy, bronchography, laminagraphy, and in rare instances angiocardigraphy. Roentgenograms showing characteristic lesions in 11 patients are reproduced, with brief case histories.

It is believed that in the past the chief error has been in watching tumors, month after month, in order to study their growth, rather than diagnosing them and operating promptly.

Twenty-four roentgenograms.

Fourteen Cases of Carcinoma of the Middle Lobe Bronchus. J. Schvarcz. *Acta radiol.* 44: 89-99, August 1955.

Fourteen cases of bronchogenic carcinoma primarily involving the middle-lobe bronchus are reported from the Sabbatsbergs Sjukhus, Stockholm. The recent emphasis upon the middle-lobe syndrome has created a need for establishing radiologic features that permit a differential diagnosis. An encysted interlobar effusion may produce roentgen features similar to middle-lobe infiltration and/or atelectasis; however, the author categorically denies the existence of an independent loculated effusion in the fissure except as a manifestation of general exudative pleurisy.

On the basis of routine roentgen appearance, the author's cases fell into three main groups showing (1) massive infiltration of the right middle lobe and adjacent parenchyma, (2) atelectasis of the middle lobe, and (3) small irregular infiltration and atelectasis of the middle lobe. Cases of the second group may resemble encysted interlobar effusions but bronchography prevents a misinterpretation. The third group must be distinguished from the middle-lobe syndrome.

Bronchography and tomography permit the differentiation of carcinoma of the middle-lobe bronchus from the middle-lobe syndrome. In this paper only bronchography is discussed.

In the middle-lobe syndrome, stenosis of the middle-lobe bronchus may be demonstrated, but bronchographic mapping of the bronchial tree distal to the stenosis also occurs. The stenosis may be surrounded by enlarged calcified nodes and the peripheral divisions of the bronchial tree may show bronchiectasis. In the presence of a tumor of the middle-lobe bronchus, the following bronchographic features have been established: (1) occlusion of the bronchus, without filling of its peripheral arborizations; (2) narrowing and crowding together of the branches of the middle-lobe bronchus. Roentgenograms illustrating these differential features are reproduced. The occlusion demonstrated in carcinoma of the middle-lobe bronchus is irregular and discontinuous, but may be abrupt, transverse, or funnel-shaped.

Sixteen roentgenograms. JOHN W. WILSON, M.D.

University of Texas, Dallas

The Diagnosis of Bronchogenic Carcinoma in Patients with Pulmonary Tuberculosis. Morton E. Shafran and Julius Kavee. *Arch. Int. Med.* 96: 157-167, August 1955.

In the past twenty years, there have been reported from various sources 114 cases of primary lung cancer in 7,848 autopsies on male and female patients of all ages with tuberculosis; this represents an overall incidence of 1.45 per cent of pulmonary carcinoma among tuberculous adults. The incidence among tuberculous men over forty years of age is undoubtedly much higher than in the entire tuberculous population, since bronchogenic carcinomas are rarely found in younger males and are less frequent, though not uncommon, in females.

Over a twelve-month period 6 patients were seen in Montefiore Hospital (New York) in whom these two diseases were associated. In all of these, the roentgen appearance of the malignant lesion was a primary factor in the diagnosis. The authors conclude that, in any patient who shows roentgen evidence of regression of tuberculous densities on rest and adequate chemotherapy with simultaneous growth (or failure to im-

prove) of another non-calcific lesion, one may strongly suspect a coexistence of carcinoma of the lung and pulmonary tuberculosis.

Several roentgen signs which suggest the possibility of carcinoma are described.

Eight roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Pulmonary Disability in Asbestos Workers. Kenneth W. Smith. *Arch. Indust. Health* 12: 198-203, August 1955.

Respiratory disease experience among several thousand asbestos workers in the United States and Canada is reviewed. Asbestosis develops in very few of the workers exposed to the fibers. An x-ray survey was made of one mill with 708 employees. Of this number, 649 (91 per cent) had normal roentgenograms. Two hundred and four employees (29 per cent of the total group) had ten or more years of service, and 2 men actually had worked more than forty years in the dust. Fifty-two employees showed a marked increase of all peribronchial markings, although none of these could be said to have asbestosis. The remaining 7 had definite x-ray evidence of asbestosis. These men exhibited various stages of pulmonary involvement, but all were working steadily at their accustomed jobs, with no signs of disability; all had been exposed to the asbestos dust for more than twenty years.

The pulmonary fibrosis resulting from prolonged inhalation of asbestos fibers produces a typical x-ray pattern. In early, or first-stage, asbestosis, roentgenograms show a fine, diffuse, homogeneous infiltration throughout both lower lung fields. The nodular conglomerate patterns of other pneumoconioses, such as silicosis, are not seen in asbestosis. There is a considerable amount of pleural reaction associated with the disease, which may account for the characteristic "ground glass" appearance.

In moderately advanced, or second-stage, asbestosis, the infiltration has increased but is still confined to the lower lung fields. The "ground glass" pattern is more apparent, and the heart borders are becoming indistinct or shaggy. There are some irregularity of the diaphragmatic outlines and beginning obliteration of both the cardiophrenic and the costophrenic angles.

In far-advanced, or third stage, asbestosis, the infiltration is still homogeneous and bilateral; it has spread to the middle and possibly the upper portion of the lung fields, but the apices remain clear. The cardiac outline is almost completely obliterated, as are the domes of the diaphragm and the costophrenic sulci.

The x-ray picture should never be used to estimate the presence or the extent of impaired pulmonary function or disability. Many patients with x-ray evidence of third-stage asbestosis have carried on their usual work and have lived fairly comfortably for several years. On the other hand, no case of definite disability has been seen without the typical x-ray pattern.

There is no typical clinical picture for asbestosis. It is insidious in onset and progresses slowly, causing respiratory embarrassment and cardiac failure.

The incidence of non-occupational respiratory disease was not found to be increased, nor was such illness more prolonged among workers exposed to asbestos dust than among non-exposed workers. Asbestosis does not predispose to the development of tuberculosis, nor does it aggravate an apparently healed lesion.

Conflicting opinions and observations and experiences with different racial groups, living in different parts of the world under variable socioeconomic and industrial conditions, make it difficult to confirm or deny the causal relationship of asbestosis and carcinoma of the lung. To these variables should be added the fact that there are different types of asbestos fibers.

Three roentgenograms; 3 electron micrographs; 4 tables.

Acute Diffuse Pneumonia of Asthmatics. Benjamin Felson and Henry Felson. *Am. J. Roentgenol.* 74: 235-241, August 1955.

The authors report a series of 16 cases of acute diffuse pneumonia with a past history of bronchial asthma. The clinical findings generally were those of respiratory infection, usually acute. The sex distribution was equal; the average age was forty-seven. Most patients had an elevated white blood cell count without eosinophilia. The clinical course of the disease was usually two to four weeks.

Roentgenograms revealed widespread pulmonary densities, usually bilateral, but occasionally unilateral. Miliary nodular densities distributed throughout both lungs was the most frequent appearance, though sometimes the pattern was that of a peribronchial distribution of minute linear infiltrations. Since the two types of roentgen picture showed considerable overlapping, the findings tended to be somewhat similar in all patients. There was no correlation between the degree of roentgen change and the severity of the clinical features. Other roentgen evidence of chronic pulmonary disease was frequently associated in the form of asthmatic emphysema.

In one instance an autopsy was performed. The minute nodules proved to be foci of acute suppurative bronchiolitis or peribronchiolar lobular pneumonia.

The authors feel that acute diffuse pneumonia of asthmatics is a separate disease entity. Other explanations for the radiographic findings would be so-called Loeffler's syndrome, pulmonary congestion secondary to heart failure, or minute patches of atelectasis. These alternate explanations are considered excluded by the clinical and laboratory findings in the reported cases. The combination of acute febrile illness, diffuse pulmonary miliary lesions, and a history of past bronchial asthma justifies a diagnosis of acute diffuse pneumonia of asthmatics.

Nine roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Severe Pulmonary Disease Subsequent to Zenker's Diverticulum. Lloyd E. Hawes and James H. Walker. *New England J. Med.* 253: 209-212, Aug. 11, 1955.

Examination of the esophagus with barium is indicated in any case of pulmonary disease of obscure origin. The authors report 2 cases of advanced pulmonary lesions, in each of which a Zenker diverticulum was easily demonstrated.

In the first case (in a 62-year-old woman) an area of consolidation was found in the base of the right lung on routine physical examination. During fluoroscopy of the chest a small, high esophageal diverticulum was discovered. Sputum examination was performed for tumor cells, and one was reported as showing atypical cells. Thoracotomy and frozen section two months after discovery of the lesion revealed chronic inflammation. The postoperative course was marked by the

recurrent accumulation of large amounts of secretion in the bronchial system, requiring several bronchoscopies and aspirations. It was decided that the secretions had accumulated and spilled from the Zenker diverticulum, and an emergency inversion and later incision of the sac was done. The secretions were thereby controlled. In this case, with a preoperative presumptive diagnosis of lung tumor, the significance of the Zenker diverticulum was not recognized.

The second patient died from a fulminating suppurative (lipoid) pneumonia. Although he had been studied for five years, the importance of a large Zenker diverticulum was not appreciated. The disease was localized roentgenologically to the left side, but it was found that the patient slept on this side and the secretions therefore flowed into the left lung when he was asleep.

A Zenker diverticulum may be a hazard to patients confined to bed during convalescence. Such patients are less able to cope with the regurgitation of fluid into the throat when unconscious or asleep, and severe paroxysms of coughing and choking may ensue. They may lead to lipoid pneumonia, bronchiectasis, and suppurative pneumonia.

Five roentgenograms. FRANK T. MORGAN, M.D.
Auburn, N. Y.

Bronchiolitis Obliterans. Arthur J. McAdams, Jr.
Am. J. Med. 19: 314-322, August 1955.

A case report and review of the subject of bronchiolitis obliterans are presented. There are 3 distinct etiologic forms of the disease: (1) following inhalation of irritant substances, (2) as a complication of pulmonary infection, and (3) of unknown origin. Fumes of oxides of nitrogen are the most common cause.

The clinical picture is variable in its inception, depending on the etiology. With inhalation of irritant fumes, there is an initial period of cough, dyspnea, chest pain, and cyanosis. Most cases terminating fatally at this time show acute necrotizing lesions of the tracheobronchial tree and massive pulmonary edema. Roentgen examination in this acute stage reveals irregular, soft mottling throughout both lungs. Patches of increased density follow the course of the bronchial tree and extend peripherally, tending to be more numerous in the mid-lung fields. There is then confluence of minute areas of atelectasis and edema, with development of larger nodules. This stage is remarkable for the rapidity with which the chest film clears in those who recover.

An interval of apparent clinical improvement lasting for several days to a month or more usually follows the initial stage. The third stage appears to have the same clinical characteristics in all groups and is unremitting. Dyspnea becomes progressively more marked, and there is variable cough and hemoptysis. Cyanosis is conspicuous. In this stage the roentgen findings may simulate miliary tuberculosis, which may offer the main problem in differential diagnosis. Pathologic examination of the characteristic miliary-like lesion shows the lumen of the bronchiole to be partially or completely obliterated by granulation tissue.

The author's case was due to inhalation of nitrogen dioxide. Attention is drawn to the fact that poisoning by oxides of nitrogen fumes is not at all uncommon.

One roentgenogram; 11 photomicrographs.

THEODORE E. KEATS, M.D.
University of California, S. F.

Diagnosis of Intrapulmonary Pleural Effusion. John W. Wilson. *J.A.M.A.* 158: 1423-1427, Aug. 20, 1955.

Intrapulmonary effusion, *i.e.*, the collection of fluid in the pleural space beneath the lung and above the diaphragm, may be a manifestation of any disease process that results in transudation, exudation, or hemorrhage into the pleural cavity. The author's observations are based on a series of 24 cases secondary to a considerable variety of conditions.

The mechanism of the confinement of effusions in the subpulmonic space is not known. Loculation is not a feasible explanation, for fluid in the intrapulmonary space may move freely throughout the pleural cavity. In addition to the factors previously described by Rigler (*Radiology* 26: 543, 1936) and Hessén (*Acta radiol.*, Suppl. 86. Abst. in *Radiology* 58: 136, 1952), the author suggests the greater negative intrathoracic pressure in the space above the diaphragm and the greater elasticity of the base of the lung. Gravitational force is undoubtedly an important influence also.

The recognition of this entity is directly proportional to the interpreter's suspicion. Any patient who shows clinical or roentgenographic signs simulating an elevated diaphragm should have further studies to exclude the presence of intrapulmonary effusion. Others have shown that pleural liquid may not be recognized roentgenographically in quantities less than 400 c.c. A possible explanation for this is that, with the patient upright, the liquid collects in the subpulmonic space and, when distributed over the diaphragmatic dome, is not apparent even as an intrapulmonic effusion. Consistent with this assumption is the theory that intrapulmonary effusion represents the earliest stage of fluid collection in the pleural cavity. Fluid in volumes exceeding 1,000 c.c. may locate exclusively in the subpulmonic space without producing any of the accepted roentgen features of pleural effusion.

On the routine anteroposterior chest film made with the patient in the upright position, the density of the liquid in the subpulmonic space forms an arcuate convexity on its superior surface and blends with the diaphragmatic shadow below to resemble an elevated diaphragm. On the lateral chest view, the normal caudal slope of the diaphragm posteriorly is maintained and the posterior costophrenic sinus may remain sharp, although ordinarily filling of the posterior pleural sinus is considered the earliest sign of pleural effusion. Occasionally, the diagnosis can be inferred from the contour of what appears to be the diaphragmatic dome. The superior border of the fluid originating medially may course obliquely upward toward the lateral thoracic wall and extend farther laterally than the normal diaphragmatic cupola, before it descends into the lateral costophrenic sinus. If any of the usual roentgen features of pleural effusion are present in association with what appears to be an elevated diaphragm, a subpulmonic fluid collection should be suspected.

If the intrapulmonary collection is on the left, its presence may be suggested by the increased distance between the inferior margin of the lung and the superior margin of the gastric gas bubble. If, by barium or carbonated beverage studies, the gastric fundus is shown to remain smooth and round and maintain its normal contour, one may exclude the possibility that the fluid is collected beneath the diaphragm. On the right side, a similar diagnostic sign would have to be

obtained by the presence of free air in the peritoneal cavity. Any accentuation of the thickness of the space between the abdominal air and the lung base may be interpreted as an interposition of fluid in the intrapulmonary space.

The most direct and informative of the roentgen procedures seems to be the demonstration of the mobility of the fluid by films taken in the decubitus and Trendelenburg positions. With careful fluoroscopy, one may see transmission of the cardiac pulsations through the liquid medium.

The author concludes that intrapulmonary pleural effusions are more prevalent than the literature would seem to suggest. The fact that they may cause considerable respiratory incapacity necessitates their recognition, since thoracentesis in a decubitus position results in rapid alleviation of symptoms.

Eleven roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Loculated Interlobar Pleural Effusion Due to Congestive Heart Failure. Report of Five Cases. John A. Higgins, John L. Juergens, André J. Bruwer, and Thomas W. Parkin. *Arch. Int. Med.* 96: 180-187, August 1955.

Loculated pleural effusions within the interlobar fissures may assume various shapes and sizes and may produce roentgen densities simulating tumor or other disease of the lung. One cause of these interlobar pleural effusions is congestive heart failure, in which event the fluid will usually disappear when cardiac compensation is restored. The criteria which have been proposed for the recognition of effusions of this nature are (1) the appearance of a circumscribed interlobar density concomitantly with the signs or symptoms of congestive heart failure and (2) the disappearance of this shadow with the successful treatment of the cardiac decompensation.

Five cases fulfilling the foregoing criteria are presented in this report and are analyzed, along with 36 cases from the literature. In 26 instances the effusions were located in the right transverse fissure alone, and in another 6 in the right transverse and right oblique fissures. Thus the transverse fissure was involved in 78 per cent of the cases. The etiology of the congestive heart failure responsible for the effusions is varied.

Necropsy had been performed in 7 cases (including 1 of the authors'), and in all of these an obliterative pleuritis between the parietal and visceral pleural surfaces was demonstrated.

Fifteen roentgenograms; 2 tables.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

THE CARDIOVASCULAR SYSTEM

Studies in Mitral Stenosis. VI. Pulmonary Vessels in Mitral Stenosis. Knut Bülow, Gunnar Björck, Oliver Axén, Hans Krook, Helge B. Wulff, and Sten Winblad. *Am. Heart J.* 50: 242-259, August 1955.

The authors studied 50 patients who were operated upon for mitral stenosis, in an attempt to ascertain the connection between the histologic changes in the lung, on one hand, and the preoperative pulmonary findings, postoperative complications, and results of surgery on the other.

Pulmonary complications, including atelectasis,

pleural effusions, and pneumonic infiltrations, were regarded as the predominant causes of postoperative disturbances and deaths. In the majority of patients, a biopsy of the lingula was obtained for histologic study at the time of operation. All fatal cases and the majority of patients with severe pulmonary complications showed pulmonary changes histologically. Morphologically abnormal lungs have proved to be particularly vulnerable in relation to operation. If the pulmonary complications are overcome, however, the prospect of satisfactory response to operation is as good in this group as in the other.

Angiopulmography was carried out in most patients and was found to yield more pathologic findings than the biopsies. The angiopulmogram, when abnormal, showed irregular vascular lumina, indicating the presence of pathologic changes in the vessel walls, probably the result of long standing contraction. This contraction is explained on the assumption that at a certain stage of influence of mitral stenosis on pulmonary circulation, the pulmonary vessels react with strong protective contraction. Pathologic changes demonstrable on the angiopulmogram seem to occur more often and earlier than structural changes in the lungs. Chest roentgenograms yield less information and are difficult to evaluate.

Since pulmonary complications were more frequent in the biopsy group and the lingular biopsies in general gave little additional information, this procedure has been abandoned. The authors feel that a preoperative angiopulmogram is of great value where pulmonary changes are suspected.

Six photomicrographs; 3 tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Congenital Mitral Atresia with Hypoplastic Non-functioning Left Heart. Sidney Friedman, Lois Murphy, and Rachel Ash. *Am. J. Dis. Child.* 90: 176-188, August 1955.

The authors present 2 new cases of congenital hypoplasia of the left heart associated with mitral atresia, without aortic valve deformity. In addition, 4 cases of combined aortic and mitral atresia or stenosis with hypoplasia of the left heart are described.

Congenital hypoplasia of the left heart is characterized pathologically by the presence of a diminutive left atrium and a markedly hypoplastic, non-functioning left ventricle. This failure of development of cardiac chambers is uniformly associated with an obstructing deformity, either atresia or severe stenosis, at one or both of the valvular orifices in the left side of the heart.

In order to maintain postnatal life in the presence of a hypoplastic left heart containing one or more atretic valves, there must be available a patent foramen ovale, or some other anomalous passage which permits arterial blood from the left atrium or pulmonary veins to reach the right side of the heart. In patients with mitral atresia or extreme aortic stenosis plus aortic atresia, another compensating anomaly essential for survival is a patent ductus arteriosus. This vessel provides the major portion of blood received by the descending aorta plus some retrograde flow to the aortic arch, its branches, and the coronary vessels. Only mixed unsaturated blood reaches the systemic circulation as well as the coronary arteries. A double burden is placed on the right ventricle. The combined deleterious effects of

right-sided cardiac failure and severe generalized anoxemia lead typically to an early death.

A review of physical signs and symptoms in this series of 6 patients reveals no consistent aids to specific diagnosis. Cyanosis is commonly absent or mild and intermittent until the onset of cardiac failure. Roentgenographic study reveals gross cardiac enlargement with evidence of right ventricular hypertrophy. The pulmonary artery is enlarged. Fluoroscopy shows right auricular enlargement and dilatation of the superior vena cava. The lung fields show no paucity of vascular markings.

Clinical features do not permit identification of the various pathological forms of hypoplasia of the left heart prior to death. The application of angiocardiology to this problem deserves further consideration.

Two roentgenograms; 1 photograph; 1 diagram; 1 table.

THEODORE E. KEATS, M.D.
University of California, S. F.

Pulmonary Stenosis and Interatrial Communication with Cyanosis. Hemodynamic and Clinical Study of Ten Patients. John A. Callahan, Robert O. Brandenburg, and H. J. C. Swan. *Am. J. Med.* 19: 189-202, August 1955.

The authors present clinical and hemodynamic data for a series of 10 patients who had pulmonary stenosis and interatrial communication, and were moderately or severely cyanotic. When the existing shunt is large and completely or predominantly right to left, the condition clinically may resemble the tetralogy of Fallot. Proof of the nature of the congenital defects in this series was obtained by cardiac catheterization.

Cyanosis was said to have been present in 8 of the 10 patients at birth or in infancy, and it probably began in infancy in at least 1 other. Three patients had combined valvular and infundibular stenosis; 6 had valvular stenosis only, and 1 had infundibular stenosis only. Considerable variation was noted in the cardiac contour on roentgen examination. The primary artery shadow was visualized in 8 of the 10 cases in the antero-posterior chest film. It was prominent in 5 patients. In only 2 cases was the heart of normal size. Pulmonary vascular markings were normal in 6 patients and decreased in the remaining 4.

In the differential diagnosis of this condition from tetralogy of Fallot, the roentgenographic findings are of great importance, particularly the appearance of the pulmonary artery segment. Concavity of this segment is more characteristic of tetralogy of Fallot. In pulmonary stenosis with interatrial septal defect with cyanosis, the pulmonary artery can usually be visualized in the postero-anterior chest roentgenogram. The electrocardiogram may also be helpful in differential diagnosis. In tetralogy of Fallot electrocardiography almost invariably discloses some right ventricular hypertrophy, but not to the extreme degree seen in some cases of pulmonary stenosis and interatrial communication with intact interventricular septum.

Patients who have pulmonary stenosis and interatrial communication are, at the present time, potentially curable. The pulmonary stenosis, if it is not a long infundibular tract, can be corrected and the interatrial septal defect closed.

Five figures, including 3 roentgenograms; 4 tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

Atypical Tetralogy of Fallot: A Noncyanotic Form with Increased Lung Vascularity. Report of Four Cases. Richard D. Rowe, Peter Vlad, and John D. Keith. *Circulation* 12: 230-238, August 1955.

The authors report their observations on 4 infants with clinical features of a large ventricular septal defect, in whom further studies suggested the diagnosis of an atypical tetralogy of Fallot. Instead of a right-to-left shunt, these patients were found to have left-to-right shunts, with consequent pulmonary engorgement and absence of cyanosis. Clinically, they all gave a history of repeated lower respiratory infections and failure to thrive.

Pulmonic stenosis, septal defect, and aortic overriding were all demonstrated by catheterization. Pressure changes proved the pulmonic stenosis, and blood samples the septal defect. The aortic overriding was demonstrated by passage of the catheter tip directly into the aorta from the right ventricle.

One of the children died and the autopsy findings are reported. Because of the left-to-right shunt, insuring an abundant pulmonary blood flow, any surgical attack on the pulmonic valve or an anastomosis appears to be contraindicated. It would seem that closure of the septal defect should correct most of the abnormal dynamics.

Four roentgenograms; 2 electrocardiograms; 2 photographs; 1 table. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Congenital Aneurysm of the Left Ventricle: A Case Report. Charles A. Bertrand and Robert N. Cooley. *Ann. Int. Med.* 43: 426-434, August 1955.

Of the causes of abnormal bulging of the left ventricular contour, as seen on the conventional chest film, ventricular aneurysm secondary to myocardial infarction is by far the most common. Approximately 8 to 10 per cent of infarctions result in aneurysm formation.

The authors' patient, a 52-year-old Negro male, was first seen in 1931, though no abnormality in the cardiac contour was observed until 1938, when a bulge of the left ventricular border was observed roentgenologically. Subsequent fluoroscopy showed paradoxical pulsation of the bulging area and a diagnosis of aneurysm of the left ventricle was made. The patient was observed for fourteen years, during which time the cardiac contour showed no significant change. Death was due to chronic pyelonephritis with uremia. Autopsy revealed a ventricular aneurysm, the structure of which suggested a congenital origin. There was no anatomic or microscopic evidence of syphilis, rheumatic heart disease, coronary arteriosclerosis or myocardial infarction, or tuberculosis of the heart. A search of the literature failed to disclose any report of a similar case.

One roentgenogram; 1 kymogram; 1 electrocardiogram; 1 photograph; 1 photomicrograph.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Kinking of the Aorta. Report of Two Cases. Lucio Di Guglielmo and Mariano Guttadauro. *Acta radiol.* 44: 121-128, August 1955.

An uncommon abnormality of the aorta in the region of the junction of the arch with the descending portion has recently been reported (see, for example, Souders, Pearson, and Adams: *Dis. of Chest* 20: 35, 1951. *Abst. in Radiology* 58: 900, 1952). The aorta, instead

of curving upward and backward just distal to the origin of the subclavian artery, swerves forward and downward to a point near the ligamentum arteriosum Botalli. There is then an abrupt kink backward and laterally until the vessel resumes its usual course. The roentgen appearance resembles that of coarctation of the aorta, although no evidence of stenosis is to be found. The condition is of interest in that it may lead to an erroneous diagnosis.

The authors' first patient was a 27-year-old man who complained of weakness since birth, precordial palpitation, slight exertional dyspnea, and vague chest pain. No physical abnormalities were present except a harsh systolic apical murmur. Plain roentgenograms showed a hemispherical opacity of soft-tissue density overlying the aortic arch and projecting beyond the left border of the mediastinum. Superimposed upon this shadow was another shadow of greater density, which was interpreted as a normal aortic arch. The condition was diagnosed by thoracic aortography. Pulse tracings taken at the level of the lower third of the legs, under resting conditions, showed a decrease in the amplitude of pulsations. The same finding was obtained at the wrists, especially on the right.

The second patient, a 12-year-old child, had had a "cardiac bruit" since birth. On admission, a loud, harsh systolic murmur was heard in the fourth left intercostal space along the sternal border. The plain roentgenograms demonstrated biventricular enlargement and engorgement of the hilar and peripheral pulmonary vessels. Cardiac catheterization showed a higher pressure in the right ventricle than in the pulmonary artery. The kinking was diagnosed by angiocardiology, which also revealed a relative stenosis of the infundibulum of the pulmonary artery and a defect in the upper interventricular septum.

This condition is probably far less uncommon than might be expected. It is still little known; appreciable mediastinal changes are not always demonstrated, and the clinical picture may be associated with very few signs and symptoms, or none at all.

The diagnosis is largely dependent upon contrast visualization procedures and especially upon thoracic aortography. The more marked the elongation of the distal part of the arch, the larger is the opacity which is seen to project beyond the left border of the upper mediastinal shadow.

The one feature distinguishing this anomaly from true coarctation is the absence of aortic stenosis and its associated clinical features. The clinical picture of aortic kinking is neither uniform nor contributory.

Souders and his associates believed the anomaly to be due to traction exerted on the isthmus of the aorta by an abnormally short ductus arteriosus.

Four roentgenograms.

P. W. MATHEWS, JR., M.D.
University of Texas, Dallas

A Paradoxical Aortogram in a Dissecting Aortic Aneurism. Banning G. Lary and Joseph A. Davis. *Ann. Surg.* 142: 304-306, August 1955.

The authors describe an unusual translumbar aortogram obtained in a 65-year-old man who had a painless dissecting aneurysm of the aorta with vascular obstruction in the right leg and arm. The contrast medium was injected into the false channel. This resulted in the demonstration of an abnormally wide aorta with retrograde flow of the medium. The find-

ings are beautifully demonstrated by a roentgenogram and several diagrams.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Visualization of the Coronary Sinus in Cineangiocardiology. Frank Campeti, Raymond Gramiak, James S. Watson, George H. Ramsey, and Sydney Weinberg. *Circulation* 12: 199-206, August 1955.

In 25 of 100 cases examined by cineangiocardiology (at 7 1/2, 15, or 30 frames per second on 35- or 70-mm. film) the coronary sinus was demonstrated by regurgitation from the right atrium. This incidence correlated fairly well with the presence of hypertension in the right atrium and ventricle, which the authors postulate as the main cause of the phenomenon.

There was frequently an associated reflux into the inferior vena cava. While caval opacification is easy to detect, however, the opacified coronary sinus tends to be confused with other opacified vessels and is sometimes identifiable only by observation of its characteristic movements.

Six roentgenograms; 1 drawing; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Reduced Intrathoracic Circulation as an Aid in Angiocardiology. An Experimental Study. I. Boerema and J. R. Blickman. *J. Thoracic Surg.* 30: 129-142, August 1955.

The authors describe a new method of angiocardiology utilizing slowing of the blood flow through the heart by increasing intrabronchial pressures to 40-60 cm. of water for short periods of time. Thus they seek to overcome some of the present difficulties of angiocardiology, as the rapid dispersion of the contrast medium, unsharpness of contours due to cardiac mobility, and the necessity for rapid film changers of expensive design.

Through a series of experiments on dogs it was demonstrated that increase in intrabronchial pressure causes slowing of the blood flow by compression of the right heart and venae cavae without leading to acute cor pulmonale. No untoward effect on the lungs or myocardium was observed. Angiocardiology (with increased intrabronchial pressure) through a right heart catheter, or by aortic catheter, showed excellent filling of all chambers, pulmonary vessels, aorta, aortic valves and coronary arteries and, with variation in technic, the peripheral arterial system. Small amounts of contrast medium containing a low percentage of iodine injected under low pressure gave good results from a technical point of view. Since the contrast is maintained for four seconds, exposures can be made with simple changing devices.

The authors believe that their method can be clinically adapted for human use, with improvement of angiocardiology studies of the coronary arteries, of congenital heart disease, with direct shunt visualization, of aortic arch abnormalities, and of other vascular systems.

[This excellent paper should be consulted in the original for technical details. The method would appear to hold promise for the improvement of present routine—A.R.B.]

Fourteen roentgenograms; 2 charts.

A. R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

Angiocardiographic Demonstration of Occlusive Auricular Thrombi in Dogs. John L. Read, Lewis H. Boshier, Felix Ferraru, Samuel Richman, and Reno R. Porter. *Circulation* 12: 247-249, August 1955.

Simulated occlusive auricular thrombi were produced in 6 dogs by invaginating the left auricle, and an attempt was made to demonstrate these as filling defects by angiocardiography. In each instance, a clear-cut defect was produced. The authors' hope is to be able to demonstrate occlusive thrombi in patients, especially those with mitral stenosis.

Five roentgenograms; 1 photograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Splenoportal Venography. Ward D. O'Sullivan and John A. Evans. *Surg., Gynec. & Obst.* 101: 235-241, August 1955.

The most effective surgical procedure for the relief of portal hypertension and its serious sequel, esophageal hemorrhage, is a venovenous shunt between the portal and systemic venous systems. Splenoportal venography gives information about the size and patency of the splenic and portal veins and prepares the surgeon preoperatively for a choice of shunts. When contrast material is introduced rapidly into the splenic parenchyma, it is picked up by the venous channels and carried into the portal venous system. By rapid serial roentgenography the opacified splenic and portal veins may be visualized.

The authors' series, from the departments of surgery and radiology of the New York Hospital, consists of 23 studies in 21 patients, 17 with portal hypertension, 2 with intra-abdominal tumors, and 2 with normal portal systems but with splenomegaly due to blood dyscrasia. A No. 17 needle is inserted percutaneously through the ninth intercostal space in the mid or posterior axillary line into the splenic parenchyma. When the needle is well in the parenchyma, blood flows slowly from it. Thirty to 70 c.c. of Urokon are then injected as rapidly as possible. Roentgenograms are taken as the injection begins and at one- or two-second intervals for twelve to fifteen seconds; 12.5 × 12.5-inch roll film is utilized.

In 19 of 23 attempts there was adequate visualization of the portal venous system. Normally no tributaries are visible and the contrast material travels rapidly to the portal vein and liver and disappears after five or six seconds. In the cirrhotic patient, with portal hypertension, the contrast medium takes a retrograde course along many portal tributaries. In every instance of portal hypertension (except for a few cases in which the esophageal tributaries of the portal vein were compressed by an inflated balloon introduced for emergency operation) retrograde flow was noted in the short gastric vessels, the coronary vein, and inferior mesenteric vein. No retrograde filling was seen in the superior mesenteric vein, and it is conjectured that it occurs only in those portal tributaries with peripheral exits in the nature of anatomic connections with the azygos and hemorrhoidal systemic veins.

Six figures illustrate the normal findings and those in cirrhosis, massive ascites, thrombosis of the portal vein, and pancreatic carcinoma with a large metastasis in the liver.

No significant complications were encountered in this short series. In 3 of the 23 attempts, the portal venous system was not visualized; twice the material was deposited intraperitoneally outside the spleen, once be-

cause the spleen was missed and once because the needle passed through it. In the third instance, the material may have entered the spleen, since a needle puncture was seen, but the films showed a large single shadow in the left upper quadrant without intravenous pick-up of the contrast material. Active bleeding, though reported by others, was not a problem.

The authors believe that the procedure may find usefulness in diagnosing pancreatic tumors as evidenced by distortion of the vein patterns, and that the opacification of the hepatic parenchyma may prove valuable in visualizing primary or metastatic liver tumors.

Seven roentgenograms; 7 schematic drawings.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Transhepatic Venous Catheterization and Venography. Howard R. Bierman, Keith H. Kelly, Laurens P. White, Alexander Coblenz, and Arthur Fisher. *J.A.M.A.* 158: 1331-1334, Aug. 13, 1955.

A method for catheterization of the right portal vein within the liver substance is described. Following the needling of the liver and the injection of a contrast medium (Urokon, Diodrast, or Iopax, preferably in 70 per cent concentration) to assure proper positioning, catheterization may be performed and the catheter left in place for prolonged intervals to carry out long-term sampling of portal vein blood.

The authors performed 144 transhepatic venipunctures in 73 patients with no serious sequelae. When the medium was introduced rapidly, under pressure, the splenic as well as the portal vein was outlined roentgenographically. In 3 patients both the hepatic and portal veins were catheterized by the transhepatic approach without untoward reaction.

There were no serious complications attributable to the procedure. In 2 cases arterial blood was aspirated; the cystic duct and the gallbladder were each entered once and outlined by the medium; in 2 other cases concentrated bile was obtained from the liver; intestinal contents were aspirated on 3 occasions, and once injection into the liver parenchyma led to transient syncope. No permanent damage resulted in these cases, however, nor did bleeding lead to complications in 2 cases that showed evidence of slight laceration of the liver postmortem.

In this study, certain venographic patterns were shown to occur regularly under specific conditions. The venogram of the uninvolved liver showed an orderly branching closely resembling the normal anatomic configuration. In the liver containing metastases, the large portal branches were sharply diverted around areas devoid of venous vascularity and exhibiting many bizarre, non-uniform vascular patterns not seen in the normal organ. In many instances hepatic metastases have been shown to be supplied by the hepatic artery. In 2 cases of portal cirrhosis an orderly but contracted vessel pattern was demonstrated, restricted to a small area of the liver.

Nine roentgenograms; 1 drawing.

SAUL SCHEFF, M.D.
Boston, Mass.

Serial Arteriography in Peripheral Atherosclerosis. C. Malchiodi and A. Rabaiotti. *Ann. radiol. diag.* 28: 354-371, 1955. (In Italian)

The importance of the demonstration of peripheral arteries in atherosclerosis cannot be exaggerated.

Today, surgical procedures make it possible to correct occlusions and, in certain conditions, to reconstruct the blood flow in the extremity. When such measures are contemplated, arteriography is of aid in determining the extent and site of obstruction, the number, type and site of the collaterals, and the condition of the vessel wall. The same type of information is desirable for arteriectomy. The plan of treatment depends largely on the arteriographic findings.

The authors use serial exposures and general anesthesia. Besides the characteristic irregularities of the lumen representing atheroma plaques, small patches are seen in the wall in the later films in the series. These are believed to represent contrast material trapped in ulcerations. The calcific rings of the wall can also be observed encroaching upon the lumen.

The most common collateral channels for obstruction at various sites are discussed.

The completeness and reliability of the information obtained by serial exposures are stressed.

Eighteen roentgenograms; 2 tracings.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Clinical and Angiographic Correlations in Arterial Stenosis. Geza de Takats. *J.A.M.A.* 158: 1502-1505, Aug. 27, 1955.

This paper is essentially a correlation of the clinical signs of vascular insufficiency of the lower limb with arteriographic studies. The importance of the roentgenographic appearance is well known to the surgeon, who must consider the possibilities of lumbar sympathectomy, plastic or homologous graft, endarteriectomy, and amputation.

Exclusive of the embolic phenomena that constitute an acute emergency for the vascular surgeon, the author divides the symptoms and clinical findings according to body sections, depending on the site of the occlusion or arterial stenosis. In the smaller stenoses, all of which appear to occur at points of mechanical stress and all of which are caused by atheromata impinging on the lumen of the vessel, the symptoms appear only on exercise. As the narrowing proceeds, differences in contralateral pulses will become detectable. Thus, an iliac occlusion demonstrated by an aortogram can be correlated with a diminished femoral pulse and cramping of the muscles of the buttocks or of the posterior thigh muscles. With calf pain, the site of occlusion or stenosis may be in the femoropopliteal area.

Two sites of injection are used to demonstrate the arterial tree of the lower extremities, namely, at the aortic level and at the common femoral level. The aortic injection may be high—just below the diaphragm—to visualize the renal and adrenal circulation, or low when interest is centered on the area of the aortic bifurcation and the two iliacs.

Clinical findings and arteriography can be combined to lead to preventive surgery before the more serious effects of stenosis are established.

Four roentgenograms; 1 graph.

SAUL SCHEFF, M.D.
Boston, Mass.

Femoral Arteriography in Diagnosis of Segmental Arteriosclerosis Obliterans. Charles M. Greenwald, Fay A. LeFevre, Joseph C. Root, and Alfred W. Humphries. *J.A.M.A.* 158: 1498-1501, Aug. 27, 1955.

The authors describe a simple but adequate and safe

method of contrast visualization of the femoral artery. A 14-gauge needle is inserted into the artery just below the femoral triangle, the obturator is removed, and a plastic catheter is introduced through the needle, which is then withdrawn.

Initially Diodrast was used as the contrast medium, but this has been replaced by Urokon. To allow for filling of the collaterals, the operator slowly injects 15 c.c. during a ten-second period. The remaining 15 c.c. is given as rapidly as possible and the arteriogram is usually obtained simultaneously with completion of the injection. The only special piece of apparatus required is a 14 × 36-inch cassette with maximum speed screens. The patient is lightly anesthetized with Pentothal.

The most important function of femoral arteriography in arteriosclerosis obliterans is to substantiate the presence of segmental occlusion so that it may be corrected. There are three demonstrable stages of arteriosclerosis obliterans. In the first there are only filling defects marring the smooth lining of the intima. The second stage corresponds to complete occlusion of a segment of the femoral artery coupled with a rich anastomosis resulting in good filling of the artery distal to the occluded segment. The final stage is also occlusive but the anastomoses are poor and there is no filling of the distal arterial segment. The result is the ischemic leg. The importance of the site and extent of the vascular involvement to the surgeon is apparent.

Three arteriograms; 1 drawing; 2 tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Ascending Phlebography in Venous Insufficiency. Torgny Greitz. *Acta radiol.* 44: 145-162, August 1955.

Ascending phlebography was used in a study of the deep veins of the lower extremities and pelvis in 251 patients, 280 examinations being performed. Indications generally were early thrombosis, inexplicable edema, or a history suggesting superficial thrombophlebitis. Fundamental pathologic changes demonstrated by the technic were dilatation, varicosities (dilatation with tortuosity), and post-thrombotic changes in the form of uneven contours, irregular lumina, and erratic coursing. These abnormalities were observed in muscular veins, communicating veins, and superficial veins, as well as in the deep veins. Venospasm was never seen in the deep veins but was occasionally observed to occur in the superficial veins.

In 98 extremities the deep veins were normal, and 15 of these gave completely normal phlebograms. In all other cases in this group superficial varicosities were present. In 56 cases pathological changes were demonstrated in the communicating veins, and 29 were found to have varicosities of the muscular veins, 26 in the calf and 3 in the thigh.

One hundred and eighty extremities showed changes in the deep veins. Varices were present in 13, extensive tortuosity in 18, dilatation alone in 25, and post-thrombotic changes in 124. Dilatation of the communicating and muscular veins was found to be more common among this group, but there was otherwise no roentgenologic difference between these patients and those with normal deep veins.

In the large group (124) with post-thrombotic changes, recanalization was found in 115 cases, or 93 per cent, which corresponds substantially with the figures of other investigators. In the majority of these

patients (75), the changes were seen in both the upper and lower part of the extremity. In 31 cases the changes were confined to the lower portion of the extremity, and in 9 the changes were found only in the upper part. Collateralization through deep channels, i.e., the profunda femoris, was found in 22 of 71 extremities with post-thrombotic changes in and at the site of the femoral vein.

There were 2 cases of acute thrombosis in the series, showing identical findings, namely, occlusion and superficial collateral channels.

Thirty-eight roentgenograms.

R. B. CONNOR, M.D.
University of Texas, Dallas

THE DIGESTIVE SYSTEM

Traumatic Rupture of the Esophagus (With a Report of 13 Cases). John W. Overstreet and Alton Ochsner. *J. Thoracic Surg.* 30: 164-180, August 1955.

Because traumatic rupture of the esophagus is catastrophic for the patient, early diagnosis and treatment are necessary. Endoscopy is a frequent etiological factor. Penetrating missile injury and ingestion of foreign bodies are other causes. The most common sites of rupture are the cervical esophagus and immediately above the esophageal hiatus, these areas being anatomically fixed and narrowed.

Diagnosis is based upon the history and such clinical signs as respiratory distress, shock, dysphagia, and interstitial emphysema. In cervical esophagus perforation there are also local tenderness, rigidity of the neck, salivation, and dysphonia.

If the thoracic esophagus is ruptured, chest films will reveal mediastinal emphysema, with or without a demonstrable fluid level, and pleural involvement in the form of hydrothorax or pneumothorax. Cervical ruptures may or may not show these findings, depending on the duration of the rupture and upon whether or not the mediastinal pleura has been penetrated. Lateral cervical films will demonstrate emphysema, especially retro-esophageally, and fluoroscopic studies with Lipiodol will show extravasation into the periesophageal tissues.

The treatment for esophageal rupture is rapid resuscitation, definitive surgical repair following debridement and lavage of the fascial spaces, and supportive therapy in the form of pulmonary expansion, tracheo-bronchial drainage, tracheotomy if necessary, administration of whole blood, and massive combined antibiotic therapy.

The authors present 13 cases of traumatic esophageal perforation. In 10 of the cases primary repair was followed by excellent results except for small, temporary fistulas in 3 cases.

Six roentgenograms. A. R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

A Radiokymographic Study of the Esophagus in Subjects Following Laryngectomy. G. Di Simone. *Ann. radiol. diag.* 28: 372-382, 1955. (In Italian)

With the aid of roentgenkymography, the author studied variations from the normal in the esophagus in 10 patients who had previously been subjected to laryngectomy. From the kymographic film, tracings were made from each small section by taking the points off the film at measured distances from the fissures, obtaining thus six curves, one for each second of a

six-second exposure. The patients were given thick barium.

Motor disturbances in the transport of the barium meal were seen in all 10 patients, their severity being in direct relationship to the extent of the surgical resection. The predominant change was hypotonicity with slowed passage of the barium meal. In the most severe disturbances almost complete uniformity of appearance of the esophagus throughout the duration of the exposure was observed, with pronounced widening. These disturbances are attributed to nervous changes resulting from the resection. In milder cases some peristalsis was seen.

Five roentgenkymograms with corresponding tracings. ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Metastatic Melanoma of the Stomach. Roberto Calderon, Jorge Ceballos, and John P. McGraw. *Am. J. Roentgenol.* 74: 242-245, August 1955.

Two cases of metastatic melanoma of the stomach are reported and the literature is reviewed. The first patient was a 44-year-old white male with a primary malignant melanoma on the left wrist and a six-year span between diagnosis of the primary lesion and the occurrence of known visceral metastases. The second patient, a 60-year-old white male, was first seen with multiple tumor nodules throughout the body. Roentgen examination of the stomach in both cases showed similar polypoid filling defects, evidently arising in the submucosa. Diagnosis of metastatic melanoma was made in each instance and in one was proved at autopsy.

Although cases of melanoma primary in the gastrointestinal tract have been reported, the authors question their authenticity. They are in agreement with Herbut and Manges (*Arch. Path.* 39: 22, 1945. *Abst. in Radiology* 45: 415, 1945) that melanoma always originates in the eye or skin.

Three roentgenograms; 1 photomicrograph.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Roentgen Manifestations of Lymphosarcoma of the Stomach and Small Bowel. Paul H. Deeb and Walter L. Stilson. *Arch. Surg.* 71: 288-298, August 1955.

The incidence of lymphosarcoma of the proximal gastrointestinal tract is difficult to determine, but over 600 cases arising in the stomach alone have probably been reported. In the small bowel the incidence seems to parallel the amount of lymphatic tissue present, the ileum being the commonest site of involvement.

Roentgen manifestations are not diagnostic, although unusual flexibility of the stomach with diffuse involvement is suggestive. In the small intestine, findings may mimic regional enteritis, deficiency pattern, and motor dysfunction. Diagnosis is important, because fairly long control is often possible with irradiation. The prognosis of gastric lymphosarcoma is considerably more favorable than of gastric carcinoma.

Five cases of lymphosarcoma involving the stomach are reported, and 4 of small bowel lymphosarcoma. Excellent response to radiation is reported in 4 of the former group and 2 of the latter. Two of the patients with small bowel lesions complicated by mesenteric involvement were living at the time of the report, more than seven years after diagnosis and radiation therapy. One of the patients with gastric lymphosarcoma was

alive after nine and one-half years and another after seven and one-half years.

Sixteen roentgenograms.

DALE UNDEM, M.D.
University of Louisville

Congenital Mucosal Cyst of the Stomach. M. Dardari and B. Zaccarelli. *Ann. radiol. diag.* **28**: 452-458, 1955. (In Italian)

Congenital mucosal cysts of the stomach are of rare occurrence. In the authors' patient, four years of age, intermittent abdominal pain led to an initial clinical diagnosis of intestinal intussusception. An inconstant mass was felt above the umbilicus. Radiologic examination disclosed a large, sharply outlined oval filling defect on the greater curvature of the stomach in the antral region, with a normal mucosal pattern. This was interpreted as representing a benign intramural neoplasm with predominant exogastric development, but an extrinsic mass adherent to the stomach could not be excluded. Surgery revealed a cystic mass, about the size of an egg, situated in the submucosa but not communicating with the gastric lumen. The histologic report was "mucosal cyst of the stomach wall, with completely differentiated epithelium." This lesion is put into the group of dysontogenetic heterotopy, with completely differentiated epithelium, according to the classification of Lauch.

Two roentgenograms; 1 drawing.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Duodenal Stasis: Possibilities and Limits of X-Ray Investigation. Clerio di Carlo. *Ann. radiol. diag.* **28**: 459-473, 1955. (In Italian)

This paper is concerned only with duodenal stasis due to extrinsic mechanical and functional causes. Among the mechanical congenital factors that can cause stenosis are: the superior mesenteric artery syndrome, annular pancreas, congenital bands, anomalies of the ligament of Treitz, and right nephrocolic ptosis causing dilatation of the inferior knee of the duodenum by traction on the mesocolon. Among acquired extrinsic factors may be mentioned hyperplastic lymph nodes, pericholecystitis, tumors of the pancreas, kidney, liver, or gallbladder.

Certain types of stasis apparently arise not from organic conditions, but probably from neurogenic disturbances. It has been suggested that duodenal hypertonia and hypotonia may be associated with analogous disturbances of the biliary tree. Sympathetic hypertonia might cause weakening or disappearance of peristalsis. There is also the possibility of spastic contractions from vagal hypertonia. In this group of cases, without apparent organic cause, are to be mentioned the megaduodenum due to morphine, acute atony after narcosis, endocrinopathies, hypovitaminosis B₁₂, disturbances in innervation from mesenteritis in the region of the mesocolon, bulbar ulcers, appendicitis, cholecystitis, hyperplastic lymphadenitis at the root of the mesentery, etc.

During the x-ray examination, it is important to give special attention to the distal end of the dilated duodenal segment. Prominent transverse rugae in this area may suggest arterial compression; a tail-like constriction may indicate either a mechanically constricting process or functional spasm. Improvement with changes in position of the patient are not constant in the superior mesenteric artery syndrome; they can be

found in some of the atonic dilatations and even in association with intrinsic duodenal lesions.

Only those cases of congenital mechanical stenosis with symptoms at birth can be considered purely mechanical; cases becoming evident later in life must be considered to have a functional component as well. Indeed, in some patients, the neurovegetative factor is more important than the underlying congenital one.

Functional spastic obstructions may be difficult to separate from the mechanical. Antispasmodics may help in this differentiation. In the purely atonic forms, one is able, under fluoroscopic guidance, to force the barium manually into distal segments. Drugs that stimulate peristalsis may assist in the diagnosis of this group.

Five cases are briefly presented. Three are considered to be due to superior mesenteric artery compression but, since the patients improved without operation, a large functional element is inferred. The fourth patient had a segmental spasm of the third portion of the duodenum, probably in relation to a toxic-infective process that also caused subicterus. The fifth case was one of duodenal atony, cause unknown.

Fifteen roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Primary Carcinoma of the Duodenum: Report of 15 Cases. Robert L. Brenner and Charles H. Brown. *Gastroenterology* **29**: 189-198, August 1955.

There have been reported in the literature 450 acceptable cases of primary carcinoma of the duodenum. To these the authors add 15, correlating the clinical, roentgen, and operative findings, and comparing the results of simple and radical surgical procedures.

The major symptom complexes are tabulated according to the location of the lesion within the duodenum. They are obstruction, ulcer-like symptoms, hemorrhage, biliary obstruction, and weight loss. The important roentgen findings are: annular infiltrating or ulcerative defects; effacement and thickening of the mucosa; irregular polypoid filling defects that narrow the lumen; dilatation of the duodenum above a constricted area, and dilatation of the stomach with gastric retention; rigidity of the duodenal wall.

Fourteen of the patients in this series were examined roentgenologically. Eight showed obstruction, and in 6 there was dilatation of the proximal duodenum. Narrowing was present at the level of the obstruction. Four patients showed irregularity of the duodenum, and in 2 there were changes in the mucosa. In only 2 cases were filling defects demonstrable. In 2 instances dilatation of the stomach with gastric retention was associated with the duodenal dilatation.

Fourteen patients underwent surgery, with no operative deaths. In 6 of these simple by-passing procedures were done for palliation only. Seven had an extensive block resection and 1 a resection of the third portion of the duodenum with primary anastomosis for a well localized lesion. Three patients were alive and apparently well at the time of the report but the survival time had not exceeded twenty months. Two patients were untraced; 9 were dead. The longest survival after palliative surgery was twenty-four months and the longest after radical surgery thirty months.

Six roentgenograms; 2 tables.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

An Unusual Case of Duodenal Deformity in Addison's Disease. Harold M. Messenger and Lee Monroe. *Gastroenterology* 29: 313-317, August 1955.

Attention is called to the anatomical relationship between the right adrenal gland and duodenum, and a case is reported in which an extrinsic compression defect of the second portion of the duodenum was demonstrated in a patient with clinical evidence of Addison's disease secondary to tuberculosis. The disease was controlled by cortical extract and desoxycorticosterone acetate, but an addisonian crisis occurred some three and a half years later and repeat studies of the upper gastrointestinal tract again showed the defect, although it seemed to be smaller. One year after this, it was no longer present and punctate calcifications were demonstrable in both adrenals.

The knowledge that the right adrenal gland can occasionally produce pressure defects of the duodenum in Addison's disease may facilitate localization of a suspected adrenal tumor.

Six roentgenograms; 1 diagram.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Intrathoracic Alimentary Duplications Communicating with Small Intestine. Harold J. Leider, John J. Snodgrass, and Abdallah S. Mishrick. *Arch. Surg.* 71: 230-233, August 1955.

A one-year-old boy was hospitalized because of a right-sided pneumonia. A chest film showed an abnormal shadow, with multiple fluid levels, in the right hemithorax. A gastrointestinal examination revealed a communication between the small intestine and the intrathoracic mass. Hemivertebrae were present in the lower cervical and upper thoracic spine.

At operation by a combined abdominothoracic approach the mediastinal mass was found to be a duplication of the small bowel communicating with the first jejunal loop. The blood supply of the intrathoracic portion of the duplication arose from the aorta. Excision of the mass with repair of the defect was done, and one year later the patient was well.

A small bowel enema is recommended as the best method of visualizing the communication (see also Snodgrass: *Am. J. Roentgenol.* 69: 42, 1953. *Abst. in Radiology* 61: 845, 1953).

Three roentgenograms; 1 photograph.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Megacolon in Psychotic Patients. A Clinical Entity. O. F. Ehrenthel and E. P. Wells. *Gastroenterology* 29: 285-294, August 1955.

The authors point out that chronic constipation is of frequent occurrence in psychotic patients and that the incidence of megacolon is greater in this group than in general medical practice. They report a series of 15 psychiatric cases in which the colon was tremendously dilated, atonic, and redundant. In most patients three to four quarts of barium were required to fill the colon, and in some instances even more. In some cases the entire colon, and in others only part of it, was dilated, but the rectum and sigmoid were always involved. There was no spastic narrowing of the bowel at any level. According to the authors, these two points are in contradistinction to the findings in true Hirschsprung's disease.

The clinical picture, pathogenesis, and management of the condition are outlined.

Two roentgenograms; 1 table.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Extraluminal Localized Gas Vesicles. An Aid in the Diagnosis of Abdominal Abscesses from the Plain Roentgenograms. W. Wayne Sands. *Am. J. Roentgenol.* 74: 195-203, August 1955.

Extraluminal clusters of gas bubbles seen on the plain abdominal roentgenogram may indicate gas within an abscess and may identify and localize the lesion. This gas formation may be endogenous (leaking from a hollow viscus), exogenous (entering the body from a sinus tract, incision, or penetrating trauma), or bacteriogenic. When trapped in a localizing abscess, the gas forms clusters of bubbles which may be single or multiple, spherical or oval, small or large. Serial studies may show coalescence and increasing size. These gas bubbles, unlike intraluminal gas, have a smooth globular shape, lack intestinal markings, may contain fluid levels, and remain constant in position. They may be seen distinctly separated from gas-filled intestinal loops or removed from the usual anatomic site of the intestine. Contrast barium studies and oblique or stereoscopic views may be necessary to confirm the extraluminal position.

These gas vesicles may be the only roentgenologic evidence of an abscess. Correct interpretation may influence the method of treatment and the site of incision.

Ten cases of gas-containing abdominal abscesses were seen by the author at a Veterans Hospital. Of these, 4 were appendiceal; 2 perirenal; 1 pericholecystic; and 1 subdiaphragmatic. One was diagnosed only as "intra-abdominal."

Thirteen roentgenograms; 2 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Roentgen Examination of the Abdomen in Acute Pancreatitis. William F. Barry, Jr. *Am. J. Roentgenol.* 74: 220-225, August 1955.

The abdominal roentgenograms of 19 cases of acute pancreatitis, diagnosed clinically at the Veterans Administration Hospital, Richmond, Va., were reviewed. The author believes that certain patterns of segmental gas distribution in the intestine are suggestive of this condition.

In 12 of the 19 cases the ascending and transverse colon were distended and showed fluid levels. In 9 cases the stomach and duodenal arc were slightly distended and frequently displayed air-fluid levels. In 10 cases, dilated loops of small bowel were seen in the mid-epigastrium left upper quadrant. A combination of any of these patterns, and particularly a dilated duodenal loop, is highly suggestive of pancreatitis. Examination in the left lateral decubitus position, with a horizontal beam, may reveal distentions not otherwise seen. One of the patients had a left pleural effusion, which has been reported elsewhere in association with pancreatitis.

Although the findings are not specific, the author believes them to have been strongly suggestive of the diagnosis in 12 of the 19 cases. The greatest number of positive findings were noted twelve to forty-eight hours after the onset of pain. Similar findings were

seen in a case of suppurative appendicitis and in a case of stab wound of the chest with diaphragmatic ileus.

Ten roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Attempted Visualization of the Pancreatic Ducts by Ampullary Reflux. H. Greenfield, L. H. Siegel, and N. De Francis. *Gastroenterology* 29: 280-284, August 1955.

By means of a specially constructed tube, the authors attempted to visualize the pancreas by reflux filling of the ducts in 2 patients. The tube was designed with two balloons, 6 cm. apart, each balloon inflatable by a separate channel. After the tube was positioned within the duodenum, the balloons were distended with air, the contents of the isolated segment were aspirated, and Diodrast was injected following introduction of various substances to promote dilatation of the sphincter of Oddi so that an open channel might be provided for reflux of the medium. In none of the attempts was any visualization of the pancreatic or biliary ducts obtained, despite the fact that in each instance there was visual evidence of adequate occlusion, both proximally and distally, of the descending duodenum and adequate distention, under pressure, of this portion of the duodenum by the contrast substance.

Two roentgenograms; 1 photograph.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Effect of Distention of Gallbladder with Air and Its Relationship to Acute Pneumocholecystitis. Carl J. Heifetz and Elliot I. Wyloge. *Ann. Surg.* 142: 283-288, August 1955.

Acute pneumocholecystitis is a type of cholecystitis complicated by the presence of gas-forming organisms in the gallbladder. As in the usual acute cholecystitis, the initial etiologic factor is obstruction of the cystic duct, almost always by a calculus. The purpose of the present study was to demonstrate the pathological anatomy which results when gas under increasing pressure is trapped in the limitedly expansile gallbladder.

The liquid contents were drained from 11 intact gallbladders, 6 of which had been removed at surgery and 5 at autopsy. Three of these were normal, the remainder showing chronic cholecystitis and lithiasis. Air was introduced through a No. 15 cannula in the cystic duct, and a record was made of the pressures at which leakage of air occurred into the tissues and when rupture ensued. Roentgenograms were obtained at intervals. In most cases the entire perimuscular layer was elevated before the occurrence of rupture, and full thickness perforation did not occur.

The authors conclude:

"1. The mechanical conditions of acute pneumocholecystitis can be simulated when the gallbladder is distended with air under controlled pressure.

"2. When a normal or diseased gallbladder is inflated, leakage of air first occurs into the perimuscular layer near the cystic duct. From there the air spreads perimuscularly until it ruptures to the outside.

"3. Radiographs of the gallbladder taken during inflation show findings strikingly similar to those of acute pneumocholecystitis.

"4. Inflation studies of removed gallbladders do not support the contention that a halo of gas translucency around the gallbladder shadow in some cases of acute

pneumocholecystitis results from distention by gas of numerous large closely packed Rokitsansky-Aschoff sinuses."

Four roentgenograms; 5 photomicrographs; 1 table.
JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Visualization of a Gangrenous Gall Bladder with Iopanoic Acid (Telepaque). Jerome L. Pollock and Martin B. Goodwin. *Arch. Surg.* 71: 304-306, August 1955.

The authors report a case in which right upper quadrant pain persisted for seven days following a fatty meal taken in the course of an oral cholecystographic examination. Findings on radiography four days and six and one-half days after the ingestion of Telepaque showed the same concentration of the medium within the gallbladder. On the later film, however, the fundus was no longer clearly outlined. This was interpreted as indicating escape of the medium into the gallbladder wall, suggesting gangrenous cholecystitis, a diagnosis which was proved by cholecystectomy and pathologic examination.

It is concluded that persistent right upper quadrant pain following a normal cholecystogram indicates the advisability of additional films. No explanation could be made for retention of the medium within the gallbladder.

Three roentgenograms; 2 photomicrographs.

THOMAS F. PADGETT, M.D.
University of Louisville

Intravenous Cholangiography. H. Stephen Weens, Jason L. Meadors, and William A. Reid. *J.M.A. Georgia* 44: 391-394, August 1955.

The authors report their experience with 100 intravenous cholangiographic studies with Cholografin. In most of the cases 40 c.c. of the 20 per cent solution was administered slowly in five to ten minutes. The reactions to the contrast medium are described as being similar in number and degree to reactions encountered in intravenous urography.

Studies on 40 normal individuals revealed that the caliber of the bile duct system varies with age. In most young individuals the common bile duct measures not more than 2 to 3 mm. in diameter. In older subjects measurements up to 6 or 7 mm. have been frequently encountered.

Examinations immediately before and after intravenous cholangiography showed that the procedure had no effect on liver function and it appears likely that administration of the contrast medium in the dosage currently recommended is without danger. In patients with marked impairment of hepatic function, most of the contrast medium will be excreted by the kidneys, resulting in a pyelographic effect. Like others, the authors have found that early visualization of the renal system may occur in patients with normal liver function.

Nine patients with acute cholecystitis were examined by intravenous cholangiography during the acute phase of their disease. In none of these patients was it possible to obtain filling of the gallbladder, but in 6 patients the common duct was seen. The lack of gallbladder opacification may serve to corroborate the clinical diagnosis of acute cholecystitis. In only 1 of 10 patients with clinical jaundice could the gallbladder and biliary duct be observed. In this series adequate duct opacifi-

cation was observed in the presence of 16 per cent bromsulphalein retention.

The authors found intravenous cholangiography particularly useful for evaluating the post-cholecystectomy patient, particularly in regard to the presence of calculi in the bile duct system.

Three roentgenograms.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Visualization of Biliary Ducts by Intravenous Injection of New Contrast Medium. Alexander J. Link, Raj K. Parida, Julius Heydemann, and Robert M. Kark. *J.A.M.A.* 158: 1491-1494, Aug. 27, 1955.

Sodium iodipamide (Cholografin), the disodium salt of N,N'-adipyl-bis (3 amino-2,4,5-triiodobenzoic acid), was used to study the biliary duct system in 21 patients. Adequate roentgenologic visualization of the large bile ducts was obtained in 15 of the series after intravenous injection of the contrast medium. The 6 patients in whom the ducts were not visualized had either severe hepatic dysfunction or air in the ducts due to previous surgery. No serious reactions occurred following slow injection of the compound.

Serial tests of liver function were carried out, including one-minute and total bilirubin, serum cholinesterase levels, measurement of gamma globulin, and a number of flocculation tests. These were unaffected by injection of Cholografin, confirming the low toxicity of the medium.

Four roentgenograms.

Criticism of "Comparative" Investigations with New Biliary Contrast Media. Walter Frommhold. *Röntgen Blätter* 8: 225-230, August 1955. (In German)

The Radiologic Visualization of the Gallbladder with Telepaque. Lothar Lange. *Ibid.* 8: 231-234, August 1955. (In German)

It is fashionable to evaluate, statistically or otherwise, the efficacy of various cholegraphic contrast media. Unfortunately, because of discrepancies in the approach employed, it is often hazardous to collate even the results obtained by several authors using the same substance. The first of the two papers listed above is a general criticism of so-called comparative studies, while the second has special reference to a report by Hartl (*Röntgen Blätter* 8: 43, 1955) comparing Telepaque and Biligrafin. In the course of the two papers the following points are made:

1. As the procedure is actually a function test, the percentage of "positive" cholecystograms varies with the incidence of liver and biliary disease among the group of patients under investigation. This might perhaps be brought out if the rate of elimination were determined by progress films.

2. With intravenous procedures (Biligrafin), the bile ducts are visualized one to two hours and the gallbladder two to three hours after the injection. With oral administration, gallbladder visualization requires twelve to fifteen hours. Obviously, roentgenograms exposed at other intervals are not comparable.

3. Equivalent dosage will avoid the correlation of results of single doses of one substance with those of double doses of another.

4. The series should be of a certain magnitude. This would prevent the drawing of presumptuous conclusions based upon 31 personal cases as compared with another group of 1,000 cases.

5. The "density" of the gallbladder shadow varies considerably with the technic employed. Low kilovoltage and increased exposure time are said to give best visualization. Up to a certain point, contrast improves with "darkness" of the negative.

6. The term "allergic to iodine" must include the specific compound. Some patients who go into severe collapse when receiving a given pyelographic medium have shown no reaction after intravenous injection of potassium iodide.

7. The hazards of intravenous cholangiography are often mentioned, yet after an estimated 500,000 examinations, thus far performed in the entire world, not a single fatality attributable solely to the procedure (Biligrafin) has been reported.

8. Commercial competition between pharmaceutical manufacturers should never be reflected in scientific publications.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Retention of the Opaque Medium During Cholecystography. J. George Teplick and Bernard P. Adelman. *Am. J. Roentgenol.* 74: 256-261, August 1955.

Since oral cholecystography presupposes the ingestion of the contrast medium some ten to fourteen hours prior to examination, retention of the opaque material proximal to the duodenum is significant. The authors report 5 cases of such retention observed during routine cholecystography. In all 5, the material was noted in the antrum and in one of these it was also observed in the esophagus. In none was there any evidence of cholecystopathy although one gallbladder showed rather poor concentration of the medium. A gastrointestinal study, which followed, failed to disclose undue gastric retention of the relatively inert barium. Four of the patients were found to have pyloroduodenal ulceration; in the fifth there was achalasia of the esophagus.

Two patients not included in the above group showed retention of the cholecystographic medium in the stomach without subsequent demonstration of upper gastrointestinal disease. In one of these patients, the pre-examination instructions were ignored; in the other, antral spasm is postulated.

The authors suggest that the radiologist look for retained medium in the stomach and bulb during cholecystography and not assume *a priori* that all extra-biliary opaque material is in the distal gastrointestinal tract. Gastric residue is usually due to the presence of upper gastrointestinal disease.

Ten roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

THE DIAPHRAGM

Intradiaphragmatic Cysts. Howard J. Kessler and Herbert C. Maier. *J. Thoracic Surg.* 30: 159-163, August 1955.

To 7 cases of intradiaphragmatic cyst which they were able to find in the recent surgical literature, the authors add 1. Of these 8 cysts, 3 were mesothelial cysts, 2 (including the authors') bronchogenic, and 3 were of uncertain origin. The mesothelial and bronchogenic cysts are forms of embryonic sequestration.

Radiographically the lesion is demonstrable as a mass in the region of the diaphragm. Occasionally it may be overlooked because of the superimposed cardiac silhouette or because the shadow does not project far enough above that of the diaphragm. Lateral recur-

bent views, barium studies, laminagraphy, retroperitoneal air insufflation, and pneumoperitoneum are aids to diagnosis.

Two roentgenograms. A. R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

THE MUSCULOSKELETAL SYSTEM

Plasma Cell Myeloma. A Clinical, Pathologic and Roentgenologic Review of 90 Cases. Charles P. Carson, Lauren V. Ackerman, and James D. Maltby. *Am. J. Clin. Path.* 25: 849-888, August 1955.

Plasma-cell myeloma is defined as a malignant disease originating in the bone marrow and progressing to a fatal termination. Although many examples of "benign" solitary plasma-cell tumors have been reported, the authors feel it unwise to regard any of them as non-malignant; their course is often one which for many years is slow and insidious. The same caution must also be exercised when dealing with the extramedullary plasma-cell tumors, most of which arise in the region of the upper respiratory tract; these are quite unpredictable in their course and may remain stationary for years before they develop into diffuse myeloma or expand rapidly as an invasive tumor, destroying bone and other tissues.

The authors' study is based on 90 cases from the Barnard Free Skin and Cancer Hospital, St. Louis, and the Ellis Fischel State Cancer Hospital, Columbia, Mo. Twelve of these cases were classified as primary extramedullary tumor, 18 as solitary myeloma, and 60 as diffuse myeloma.

The predominance of plasma-cell myeloma among men has been well established; 60 patients in the present series were males and 30 females. There were only 6 patients below the age of forty and 3 above the age of eighty. The duration of symptoms from the time of onset to diagnosis was often difficult to establish; it varied from a few days to two years, and in rare instances was even longer. In three-fourths of the patients with primary skeletal involvement, symptoms had been present less than six months. Bone pain, most often in the back, was the most usual complaint and occurred in 76 per cent of the cases with bone involvement. Weakness, weight loss, and fatigability, often associated with anemia or bleeding tendencies, were also common. The bones most frequently involved were those of the vertebral column, ribs, skull, pelvis, and femur. Pathologic fractures were found in over half of the cases. Associated neurologic abnormalities were present in 35 to 40 per cent. In diffuse myeloma, the onset of severe neurologic disturbances seems to herald an early death.

Because of replacement of bone marrow by tumor, anemia is an extremely common finding in multiple myeloma. Two-thirds of the patients in the authors' series with multiple bone lesions had red cell counts of less than 3,000,000 per cu. mm.

Hyperglobulinemia is a frequent accompaniment of multiple myeloma and was found in 72 per cent of the cases in which the examination was made. The abnormal globulin is most often in the gamma fraction. The test for Bence-Jones protein was positive in 45 per cent of the 60 patients with diffuse myeloma at some time during the course of the disease.

Metastatic calcification was found in 10 of the 27 autopsied cases in the present series. In 2 of these there were renal calculi. Areas of calcification were

noted in the lungs, mucosa of the stomach and small bowel, renal tubules, endocardium, myocardium, and urinary bladder. In 2 autopsied cases there was definite enlargement of one or more parathyroid glands.

The most common change of the renal architecture in diffuse myeloma is the presence of casts involving a large portion of the tubules. Multiple large casts with laminated appearance were observed in 12 of the autopsied cases. Many of the other cases showed small casts or an occasional large cast.

The roentgenographic pattern is, by itself, unreliable in establishing a diagnosis of myeloma, since it may easily be confused with other conditions producing discrete osteolytic lesions. Evidence of new bone formation or periosteal reaction, however, should suggest that the process is other than myeloma. Osteoporosis was a common finding in the authors' series. In the spine this was often associated with vertebral collapse even in the absence of any roentgen signs of a localized destructive lesion. Besides the so-called "typical" pattern, there may be large lesions of destructive type, sometimes associated with tumefaction involving surrounding areas, or cystic trabeculated lesions. These may be seen in apparently solitary bone lesions.

At the present time treatment of myeloma is directed toward producing beneficial, though usually not curative, results. Roentgen therapy may control localized lesions well and may even eradicate them. One patient in the series is living twenty-two years after irradiation for a myeloma involving four vertebrae. Of the chemical agents now available, the best seems to be urethane, either alone or in combination with ACTH or cortisone. Even this does not give any striking relief in the majority of patients. Toxic effects may be quite severe.

Of the 60 patients with multiple bone involvement, only 4 were living at the time of the report. Thirty-one (52 per cent) died within three months of diagnosis. Twenty-three of the 60 received little or only supportive treatment: 17 of these died within one month of diagnosis; 5 lived for periods of one to eighteen months; only 1 survived as long as twenty-one months. The majority of patients receiving some type of more definite therapy lived from six to twenty-four months, and some even longer.

Thirteen roentgenograms; 7 photomicrographs; 2 tables.

An Uncommon Familial Systemic Disease of the Skeleton: Hyperostosis Corticalis Generalisata Familiaris. F. S. F. van Buchem, H. N. Hadders, and R. Ubbens. *Acta radiol.* 44: 109-120, August 1955.

This is a report of a peculiar systemic disease of the skeleton which did not conform to any classified osseous disease, occurring in a twin brother and sister. Progress examinations over a number of years were possible, and the sister, dying at the age of fifty-two years, was studied at necropsy.

The abnormalities of the bone consisted mainly of marked hyperplasia of the corticalis with extensive osteophyte formation; the cortical dimensions were increased and the marrow cavity reduced. The cortical thickening was chiefly localized to the diaphyses of the long bones, the metacarpals, metatarsals, and phalanges. The spongy bone showed an ordinary structure. There were no abnormalities of internal organs. The calcium and inorganic phosphate contents of the serum were normal, but the alkaline phosphatase was slightly increased. The blood picture was otherwise normal.

The following conditions are considered in the differential diagnosis:

(1) *Osteopetrosis* (marble bone disease of Albers-Schönberg), which, however, affects principally the vertebrae, pelvis, and metaphyses and epiphyses of the long bones; (2) *osteomyelosclerosis*, which differs from the cases reported in the occurrence of extramedullary hematopoiesis; (3) *hyperostosis generalisata with pachydermia* (Uehlinger), showing sclerosing atrophy of the bone marrow, not present in the authors' cases; (4) *osteopathica hyperostotica multiplex infantilis* (Camurati-Engelmann's disease). In this last disease, as in the cases reported here, the symmetric osteosclerosis is localized predominantly to the diaphyses of the long bones and the phalanges; however, the vertebrae and pelvis are rarely affected and the skull changes are less extensive. The bone marrow becomes fibrotic.

Five roentgenograms; 7 photographs; 6 drawings; 2 tables.

B. J. PARNELL, M.D.

University of Texas, Dallas

The Vascular Pattern as an Aid to the Diagnosis of Bone Tumours. A. C. Begg. *J. Bone & Joint Surg.* 37-B: 371-381, August 1955.

The diagnosis of bone tumor is often difficult even with careful clinical, radiological, and pathological examination. Thus any further information afforded by study of the vascular pattern seems worth while.

Arteriography is performed under local anesthesia with direct arterial puncture. Thirty-five per cent Diodone is sufficient for all arteries except the aorta, for which a 70 per cent solution is used. A tourniquet applied just distal to the lesion is helpful, and in the shoulder and pelvic girdles is essential. Occasionally, if a hemangioma is suspected, the diagnosis can be determined by direct injection into the lesion.

In the normal arteriogram of a limb, the branches of the main artery are seen to decrease progressively in caliber, and periosteal vessels and the nutrient artery are never visualized. Although stripping of the periosteum at surgery results in little oozing, it is fallacious to think of the blood supply to bone as relatively poor. Direct injection of contrast material into bone indicates its extreme vascularity, particularly near an epiphysis, and emphasizes the extraordinaire capacity of the minute periosteal vessels. The nutrient artery of a long bone appears to play little part in its nourishment, and may be regarded as a vestigial structure.

As in tumors of the brain and kidney, so in malignant bone tumors the blood supply is increased. Periosteal vessels are visible, and the feeding arteries and draining veins are of increased caliber and tortuous. A third feature is increased opacity of the lesion as a result of the rapid circulation through the vascular sinuses. Negative findings or simple displacement of vessels suggest a benign lesion.

In some cases the arteriogram provides such sure evidence of malignancy that the hazard of dissemination by biopsy may be avoided. Six illustrative cases are presented.

Twenty-four roentgenograms; 4 photographs.

C. M. GREENWALD, M.D.

Cleveland Clinic

Contribution to Diabetic Arthropathy. H. Goecke. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 83: 243-247, August 1955. (In German)

While diabetic arthropathy is of rare occurrence,

knowledge of its existence is important, since the bone and joint changes are practically identical with those found in association with *tabes dorsalis*, *syringomyelia*, *myelodysplasia*, and peripheral nerve lesions. In contrast to similar arthropathies, the diabetic type usually involves the tarsal joints. The history of diabetes goes back more than ten years, and its control is usually difficult. Frequent complications are albuminuria, diabetic retinitis, and increased protein in the cerebrospinal fluid. The author believes that hyperinsulinism causes circulatory disturbances which in turn lead to aseptic-necrotic transformation of bone. The prognosis is bad, as the joint changes tend to be progressive and difficult to control. With increased life expectancy of insulin-treated diabetics, arthropathy is apt to be more frequently observed and is therefore of practical interest.

A case is reported in a woman of thirty-two, known to have had diabetes mellitus for fourteen years. Her daily insulin had to be reduced from 40 to 25 units because of frequently occurring hypoglycemic reactions. There was a six months history of swelling and reddening of the left foot with transient pain and skin ulcerations. Roentgenograms revealed progressive destruction of the bones and joints of the left tarsus over a period of a year. There were fragmentation, soft-tissue thickening, marked talipes valgus deformity with sagging of the tarsal arch, a plantar spur, calcification of peripheral arteries, and a tendency to progressive bone sclerosis. The control of the diabetes was made even more complicated by an intervening pregnancy, and finally destructive bone changes developed in the right foot, with fragmentation of the medial cuneiform and soft-tissue swelling.

Five roentgenograms.

ERNEST KRAFT, M.D.

Newington, Conn.

Contribution to Milkman-Looser Disease. R. Bo-gaert and C. Dochez. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 83: 221-224, August 1955. (In German)

Symmetric spontaneous fractures are known to occur in association with progressive osteoporosis or osteomalacia. Three such cases were observed by the authors within a short period of time.

The first patient was a female, aged 53, who experienced progressive bone pains over a period of eight years following a gallbladder operation. Examination showed generalized osteoporosis, rib fractures, and transformation zones in both scapulae. The patient had four to six bowel movements daily but responded well to a low-fat diet and medication with vitamin D and calcium. The fractures healed promptly.

The second patient was a woman of 74 who had undergone gastrectomy for ulcer seven years previously. Subsequently diarrhea developed, alternating with constipation. During the past three years diarrhea had predominated and skeletal pains had occurred. The patient was cachectic, pale, and unable to walk. She was found to have glossitis, hypermotility of the small intestine, and osteoporosis. Pseudofractures were present in both tibiae, the right ulna, ribs and pelvis. Treatment was the same as in the first case, with folic acid in addition. After a few months the patient was able to walk again.

The third case was that of a female of 69, with cholelithiasis, pains in the joints and in the left leg, and occasional diarrhea. A generalized osteoporosis

was present, the ribs were caved-in bilaterally, and pseudofractures were noted in the left tibia and fibula. The therapeutic regime was the same as in the two earlier cases.

Common features in all three cases were osteomalacia with bone pains and hypochromic anemia developing many years after gallbladder disease or gastric resection with subsequent steatorrhea. Pseudofractures occurred in diaphyses as well as in metaphyses, so that neither static factors nor altered vascularization played a predominant role. Blood calcium and phosphorus were low, which could suggest compensatory hyperparathyroidism. Therapeutically, large doses of calcium and vitamin D parenterally and a low-fat diet are indicated.

Seven roentgenograms. ERNEST KRAFT, M.D.
Newington, Conn.

The Ageing Vertebral Column (Macro- and Histo-radiographical Study). The Barclay Prize Essay, 1955. Fedor Bohatirchuk. Brit. J. Radiol. 28: 389-404, August 1955.

The author attempts to systematize existing knowledge on the radiological aspects of the aging spinal column, discussing those radiological signs which appear to be typical of the aging process. Following an excellent review of the literature, he reports his own radiographic and historadiographic (microradiographic) studies, including observations on dogs for comparison with the findings in man. The process of aging in the human and animal spine was found to follow approximately similar lines, in spite of the fact that the canine vertebrae do not support the weight of the body.

Seventy-five men and women, of whom 69 were over sixty years of age, were chosen for this study. It was found that normal aging signs may be present in persons who do not complain of pain or even discomfort. Both bone atrophy (osteoporosis) and bone hypertrophy develop together in the normal aging vertebral column. Vertebral atrophy was shown to be distinct from senile osteoporosis, which is a disease entity with typical clinical symptoms.

Bone atrophy in the vertebrae is revealed by two signs: a general decrease of x-ray absorption and morphological changes. Historadiographs of the atrophic vertebrae indicated that loss of calcium takes place not only *via* osteoclasts, but also through other channels. Consequently the old theory of halistresis has again to be revived.

The first sign of bone hypertrophy is an increase in the size of the vertebral body due to enlargement of the apophyses. Lateral radiographs show a small protuberance on the ventral part of the body, just below the superior apophysis. This evidently is the sign of initial ossification of the anterior longitudinal ligament. In its further development there is protrusion of the ventral and lateral corners of both apophyses outside the body of the vertebra, in the form of "lipping." The author's historadiographic studies showed that in case of normal aging bone structure in the area of such lipping is closely similar to that of the principal bone. This leads to the conclusion that the hypertrophic process represents a continuation of bone growth rather than the development of abnormal bone. It thus becomes necessary to revise the conception that every case of lipping observed is a sign of hypertrophic arthritis, since these changes may be observed in normal old age without clinical signs and symptoms.

Armed with his accumulated information, the author attempts to draw a borderline between normal and pathological aging in bones. He also describes the peculiarities of the normal aging process in different parts of the vertebral column.

Twenty-four roentgenograms; 4 historadiographs; 2 macroradiographs; 1 graph; 1 table.

J. R. GISH, M.D.
Henry Ford Hospital, Detroit

The Natural History and Prognosis of Infantile Idiopathic Scoliosis. J. C. Scott and T. H. Morgan. J. Bone & Joint Surg. 37-B: 400-413, August 1955.

In assessing the prognosis of scoliosis, it is becoming apparent that other aspects of the natural history are equally if not more important than analysis of curve patterns. The teaching that the earlier in life the curve starts the worse it will become is in some respects fallacious, but offers the authors sufficient justification for focusing their attention on infantile scoliosis.

In the series of 28 cases of infantile idiopathic scoliosis reviewed here, only curves present by the age of two years were considered. These 28 cases represented 12.8 per cent of a total group of 218 patients with idiopathic scoliosis seen at Wingfield-Morris Orthopedic Hospital, England. Attention is called to the lack of reference to this type of infantile scoliosis in the American literature, apparently due to its rarity.

There are several features suggesting that infantile scoliosis is distinct from scoliosis starting after the age of two. (1) There is no sex differentiation, whereas in the older group, girls are affected more often than boys, in the ratio of 2 to 1. (2) The curve pattern is almost exclusively thoracic, while after two years only one-third of the cases are thoracic. (3) The apex of the curve is to the left in 93 per cent of cases; after two years it is to the right in 85 per cent.

Graphic analysis reveals that, when the major curve starts to increase, the rate of progress is fairly constant until growth ceases. An average patient with an initial curve of 30° will deteriorate 5° per year, and by the age of fourteen a major curve of about 100° can be expected. There is, however, considerable variation in the age at which the deterioration starts. It may take place rapidly and continuously from onset, or the curve may remain stationary for several years.

While radiographic analysis offers a convenient method of observing the progression of a curve, assessment of the patient requires clinical evaluation. The important factors in determining clinical variations are (1) the length of the major curve, (2) the degree of rotation of the vertebrae at the apex of the curve, (3) the age at onset of deterioration, and (4) the rate of deterioration. Variation in the shape and size of the thorax relative to the rest of the body is particularly important, for the greatest functional disability arises from this thoracic deformity. Vital capacity is reduced, and cardiovascular function impaired. Pain, an unusual symptom in the developing curve, is relatively common later in life due to root compression, pressure of ribs on the iliac crest, and secondary degenerative arthritis.

Also reviewed are 7 cases of resolving infantile idiopathic scoliosis. Two subtypes can be recognized. In Type I, the curve is shown to diminish gradually until the spine is normal. In the other, the curve remains stationary, or even becomes slightly worse, for two or three years and then suddenly disappears within

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a few months. It is important to differentiate these cases from the progressive group. The resolving group was diagnosed at an earlier age, averaging only five and a half months as opposed to fifteen months for the progressive series. Also, the major curve was usually less than 20°, and rotation of apical vertebrae was minimal. The average interval between discovery of the scoliosis and straightening of the spine was two years and a half.

Infantile idiopathic scoliosis is to be differentiated from scoliosis with congenital abnormalities and from scoliosis of known etiology (paralytic, thoracogenic, and associated with neurofibromatosis and other neurologic conditions). Scoliosis of known etiology can usually be easily excluded. Diagnosis of congenital scoliosis requires x-ray demonstration of the congenital defects. This can be confusing only in later life, because of secondary structural change. With exclusion of congenital scoliosis and cases of known etiology, the differential diagnosis remains between progressive and resolving infantile idiopathic scoliosis. This may be difficult and remain in doubt up to the age of three years.

Twenty-seven roentgenograms; 13 photographs; 3 graphs; 4 tables.

C. M. GREENWALD, M.D.
Cleveland Clinic

Kyphoscoliosis. J. I. P. James. *J. Bone & Joint Surg. 37-B:* 414-426, August 1955.

The true deformity of kyphoscoliosis has received little attention. This term has been used loosely to describe an effect due to rib rotation without determining whether a kyphosis was in fact present.

Thirty-three cases of kyphoscoliosis are reported here, falling into three etiological groups. Twenty-one were congenital, with x-ray findings including congenital wedging, vertebral fusion, hemivertebrae, absence of vertebral bodies, spina bifida, and rib anomalies. The mechanisms leading to this deformity are obscure. In several instances it appeared that multiple bodies were fused. Absence of the body epiphyses, with deficient anterior growth, may then have been responsible for the kyphosis, which showed its major development during the period of rapid growth in prepuberty years.

Sixteen of the congenital cases were thoracolumbar and 5 cervicothoracic. In the latter location, there was remarkably little visible deformity even with a 90° kyphosis. In 5 cases paraplegia developed.

When kyphoscoliosis has developed, there appears to be every likelihood of severe and progressive deformity. Treatment in the first instance has always been conservative, but results have been poor. Early correction and fusion are advocated by the author in the hope of preventing paraplegia, and because correction of the old established deformity is difficult or impossible.

Radiologically, kyphoscoliosis should be suspected when vertebral bony details are confused. On the anteroposterior view, the combined deformities of kyphosis, lateral curvature, and rotation produce overlap and ill-defined vertebral detail, while the ribs and pelvis show normal definition. When the smooth curve of scoliosis becomes angular or "squared," and if there is one clear disk space, the diagnosis is suggested.

The author's series included 10 cases of idiopathic kyphoscoliosis. These were all from the infantile

scoliosis group, which by definition begins before the age of three, with x-ray exclusion of congenital anomalies. This pattern of scoliosis is found only in the thoracic region, usually mid-thoracic. Paraplegia was not seen. Treatment, as in the congenital group, is by distraction and fusion.

Kyphoscoliosis in neurofibromatosis is a well recognized entity. Two cases were included in the present series. One was high thoracic and the other thoracolumbar, both with characteristic pigmented skin patches.

Twenty-four roentgenograms; 2 photographs; 2 tables.

C. M. GREENWALD, M.D.
Cleveland Clinic

Spondylitis: Roentgenologic and Clinical Aspects.

J. E. W. Brocher. *Schweiz. med. Wchnschr. 85:* 830-832, August 1955. (In German)

This is a philosophic article about the many possible mechanisms by which osteoarthritis may cause complaints and which, at one time or another, have been considered the exclusive cause of lumbago, sciatica, and cervicobrachial discomfort. The herniated disk theory seems to be on the decline, and hyperemia with edema within the neural foramina now on the road to public favor.

Spondylolysis, spondylolisthesis, scoliosis, kyphosis, and various congenital bone abnormalities are undoubtedly a frequent cause of the demonstrable changes of osteoarthritis, but it has become increasingly obvious that there is no correlation between roentgen findings and symptoms. On the contrary, only a minority of patients whose radiographs disclose osteoarthritis of the spine have any complaints. Radiologically demonstrable osteoarthritis is merely a *disease potential* but not a disease except when there is evidence of posterior spur projection, a rare occurrence almost exclusively confined to the cervical region, where the unciform processes favor its occurrence. The only roentgen sign of reasonable clinical importance is narrowing of the intervertebral disk space, and perhaps also narrowing of the diarthrodial space. The other roentgen signs (marginal sclerosis, osteophyte formation, disk calcifications, and vacuum phenomena in the disk space) show no correlation with the patient's complaints. Furthermore, the author's own autopsy studies showed that a well preserved intervertebral space may harbor severe disk lesions.

The profusion of available theories, most of which are mechanistic but some of which are genetic, degenerative, circulatory, neurogenic or hormonal in concept, suggest the need for further research. Our present-day confusion is caused by the erroneous assumption that osteoarthritis is a disease of old age. This has closed the eyes of most workers to the fact that the cause of the disease may have occurred in the second or third decade of life, i.e., twenty to fifty years before the disease has become radiologically manifest. The author concludes that—with the possible exception of Scheuermann's disease—when the roentgen diagnosis of osteoarthritis of the spine is made, it is much too late to find its cause.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Multiple Ruptured Lumbar Discs. Ralph B. Cloward. *Ann. Surg. 142:* 190-195, August 1955.

A plea is made for a more diligent search for multiple

disk lesions by the use of discography (introduction of a radiopaque water-soluble medium directly into the disk). By this means degenerated disks or a ruptured disk without herniation, not diagnosed by myelography, can be demonstrated prior to operation and the information thus obtained will obviate the necessity of exploration of a second interspace and the danger of removing a normal disk merely because it has a "boggy feel." If a spinal fusion is to be done, its extent can be predetermined.

In a series of 206 patients seen since 1951, in whom both myelography and discography were done, 33 (16 per cent) were found to have multiple ruptured lumbar disks. The diagnosis was made by myelography in 13 cases and by discography in 20. In all of the group the pathologic disks were removed and replaced by bone grafts, and the vertebral bodies were fused. While the morbidity was higher than with single joint fusions, due probably to the longer operation and the handling of more nerve roots, the end-results would seem to justify this type of treatment. Twenty-nine patients were relieved of all symptoms six months to four years postoperatively.

Nine roentgenograms. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

A Contribution to the Recognition of the Vertebra Plana of Calvé. F. Viterbo and B. Fonzone. *Ann. radiol. diag.* 28: 325-336, 1955. (In Italian)

The authors describe a case of vertebra plana with demonstration of early changes and eight years follow-up. The majority of authors recognize three roentgen stages: an initial stage, a static stage, and the stage of reconstruction.

The initial stage, which lasts for only a few weeks, is often missed by the clinician and radiologist. In the few cases in which it has been described it consisted in a slight increase of density of the central portion of the vertebral body. In the second stage there is compression due to necrosis, with great flattening and increase in width of the intervertebral spaces. This stage lasts from two to twelve months. Reconstruction to a more normal and regular appearance requires six to eight years or more.

In the case presented, all three stages are demonstrated. In addition to the bony changes in the initial stage, a fusiform soft-tissue shadow was also observed. This has sometimes been erroneously interpreted as an abscess, but in reality it represents edema of the paravertebral ligaments in the area of involvement. Reconstruction in this instance was very slow; even after eight years it was not complete. A central dense plate surrounded by newly formed healthy bone persisted.

Fourteen roentgenograms.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Acute Episodes with Calcification Around the Hip Joint. G. Blundell Jones. *J. Bone & Joint Surg.* 37-B: 448-452, August 1955.

Acute shoulder pain of sudden onset, due to rupture of a calcific deposit, is a recognized entity. With rest and sedation the condition clears spontaneously, and there is absorption of the calcific material. The author reports 7 similar cases occurring in the hip. To his knowledge this occurrence has not previously been recorded in this location.

Hip calcification is commonly reported in three situations: (1) in the tendon of the gluteus medius, (2) in the bursa between the tendon of the gluteus medius and the greater trochanter, and (3) on the undersurface of the gluteus medius, not connected with the trochanter. These cases are mainly of the chronic type. In 6 of the author's cases, stereoscopic views suggested that the calcific material was either on the undersurface of the gluteus medius or in the capsule of the joint. The physical signs were those of acute synovitis of the hip, suggesting that the deposit ruptured into the hip joint, rather than from tendon into soft tissue or bursa. The calcific material is extremely irritant and provokes a hyperemic reaction facilitating its absorption.

It may be that this new type of calcification in the joint capsule is particularly liable to give rise to an acute episode because of easy rupture into the joint.

Fourteen roentgenograms.

C. M. GREENWALD, M.D.
Cleveland Clinic

Deposition of Calcium Salts in the Popliteus Tendon. N. T. Holden. *J. Bone & Joint Surg.* 37-B: 446-447, August 1955.

Two cases of deposition of calcium on the outer side of the knee are described. The condition is distinctly uncommon, calcification on the medial side only having been previously reported. In 1 of the author's cases the deposit resolved with conservative treatment; in the other after an operation, at which the deposit was found in the tendon of the popliteus.

Four roentgenograms. C. M. GREENWALD, M.D.
Cleveland Clinic

Deposit of Calcium Salts at the Wrist. Report of Two Cases. Edmund Shephard. *J. Bone & Joint Surg.* 37-B: 453-455, August 1955.

Two cases of transient calcium deposits at the wrist demonstrated roentgenographically are reported, one of the patients having previously had a deposit at the shoulder. Clinically there were acute pain, swelling, and tenderness. Both lesions occurred at the base of the thumb metacarpal in the region of the abductor pollicis longus insertion. There was spontaneous absorption within a month in each instance.

Seven roentgenograms; 2 photographs.

C. M. GREENWALD, M.D.
Cleveland Clinic

GYNECOLOGY AND OBSTETRICS

The Use of Pneumoperitoneum in Gynecologic Diagnosis. G. Carnevali, U. Lucarelli, and P. Paracchi. *Radiol. med. (Milan)* 41: 721-741, August 1955. (In Italian)

The use of pneumoperitoneum in gynecologic diagnosis was described as early as 1918, but fear of its dangers caused its abandonment. The introduction of oxygen and carbon dioxide as contrast media and improvement of radiologic apparatus have made the procedure safe and practical.

The technic is as follows: Breakfast is withheld on the day of the examination. The patient is instructed to void and is catheterized if necessary. The introduction of air through puncture of the anterior abdominal wall is preferred to transtubal insufflation, which

presents the danger of spread of infection or dissemination of neoplastic cells. With the patient in Trendelenburg or knee-chest position, 1,000 to 1,500 c.c. of gas is introduced into the peritoneal cavity. The films are taken with the patient in Trendelenburg position, the central rays being perpendicular to the axis of the last coccygeal vertebra. An anteroposterior and two oblique views (30°) are obtained.

Fifty cases were studied by this method, supplemented by hysterosalpingography as indicated. Sixteen cases believed to be most illustrative are presented in the article. In most instances the preoperative diagnosis was confirmed at surgery.

Since the procedure demonstrates the outlines of the pelvis, uterus, round ligaments, tubes, ovaries, and parametria, the relationships and respective size of these structures can be evaluated. Masses in this region are outlined, and the displacements that they cause can be studied. The usefulness of clinical information in interpretation of findings is stressed.

Seventeen roentgenograms with accompanying drawings; 3 photographs.

ALEXANDER R. MARGULIS, M.D.
University of Minnesota

Foreign Bodies Lost in the Pelvis During Attempted Abortion With Special Reference to Urethral Catheters.

David Zakin, William H. Godsick, and Benjamin Segal. *Am. J. Obst. & Gynec.* 70: 233-251, August 1955.

Seven cases are reported in which non-metallic bodies—urethral catheters in 6 cases and a glass cocktail stirrer in 1—were retained in the pelvis after introduction in an attempt at abortion. The foreign body could be demonstrated by x-ray examination in all cases except 1 in which a 12 F woven silk catheter had been employed. Usually the plain film of the abdomen demonstrates the presence of the foreign body, its nature and location. In special cases, auxiliary procedures with a metal sound in the uterus or hystero-graphy may be used in the absence of a viable fetus.

Six of the patients gave a history of insertion of the foreign body; in the seventh the diagnosis was made by chance, radiographically. Most often, the abortifacient object is introduced through the cervix, perforates the uterine fundus or anterior wall, and lodges in the peritoneal cavity without further visceral damage. The prognosis is usually good.

Seven roentgenograms; 1 photograph; 1 table.

R. L. EGAN, M.D.
University of Texas, Houston

Early Roentgen Diagnosis of Spastic Contraction Ring in the Uterus (Bandl's Ring) During Labor and Roentgenographic Demonstration of the Subcutaneous Fat Deposits of the Fetus ("the Fat Line") and of the Placenta. Niels Lauge-Hansen. *Am. J. Roentgenol.* 74: 315-322, August 1955.

On the basis of 15 cases, the author discusses the causes that transform a contraction ring of the normal pregnant uterus into a "Bandl's" ring of spastic uterine musculature. Among these are abnormal presentation, rupture of the membranes with the presenting part high, and the injudicious use of oxytocics. The author considers this segment of spastic uterine musculature a functional rather than an anatomical entity. In support of this view he reports a case of breech presentation where the spastic ring of tissue was not at the

usual site of the lower limits of the contractile uterus, just above the internal os, but high in the fundus between the head and trunk.

During labor, the normal physiological contraction ring is absorbed into the uterine musculature. Under the adverse influences noted above, this ring becomes more prominent and impinges on the least resistant portion of the fetus, the region between the head and shoulders. Roentgenographically, particularly in the lateral view, this ring may be seen as a triangular soft-tissue density with the blunt apex of the triangle in the region of the neck demarcated from the fetus by subcutaneous fat deposits—the "fat line."

On suspicion of irregular uterine action, a roentgen examination in an early stage of labor may provide the diagnosis, so that proper obstetric procedures can be instituted to relieve the mother and improve the prospects of survival of the child.

Three cases are reported.

Seven roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

A Case of Physopyometra. A. H. C. Walker and D. Pearson. *J. Obst. & Gynaec. Brit. Emp.* 62: 540-541, August 1955.

Physopyometra is the simultaneous occurrence of gas and pus within the uterine cavity. A case is reported in a 71-year-old patient, who was seen a month after radium insertion for advanced cervical cancer. She had been complaining of constant and distressing abdominal pain and distention for three weeks. On palpation, a soft mass was discovered, arising from the pelvis to 1 inch above the umbilicus. The upper two-thirds was resonant to percussion and the lower third was dull. Roentgenograms taken in the supine position showed a large round pelvic mass. With the patient erect, the presence of gas and a fluid level were demonstrable.

With the escape of gas and fluid from the uterus, there was a marked diminution in its size. Bacteriological report on the fluid revealed *Staphylococcus albus* overgrown by *Proteus vulgaris*.

Three roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

THE GENITOURINARY SYSTEM

Further Consideration of Deaths and Unfavorable Sequelae Following the Administration of Contrast Media in Urography in the United States. Eugene P. Pendergrass, Philip J. Hodes, Roderick L. Tondreau, Clinton C. Powell, and E. Douglass Burdick. *Am. J. Roentgenol.* 74: 262-287, August 1955.

This paper deals with the unfavorable reactions, including death, following intravenous urography from 1942 to 1952. The material was largely obtained from relevant answers to questionnaires submitted by 1,249 members of the American College of Radiology, and covered about 3,800,000 urograms. An earlier survey of a similar nature was published in 1942 (Pendergrass *et al.*: *Am. J. Roentgenol.* 48: 741, 1942. *Abst. in Radiology* 41: 98, 1943).

Non-fatal reactions varied in severity from local pain at the site of injection to the alarming manifestations of convulsions. Regional venospasm was a fairly common event. Urticaria, angioneurotic edema, and flushing were the allergic manifestations most often noted.

An acute reaction, apparently threatening life, consisted in syncope, hypotension, apnea, weakness, cyanosis, and almost complete absence of perceptible cardiac action. Acute pulmonary edema, carpopedal spasm, headache, and chills were also reported.

A total of 31 deaths occurred. Of these, 25 were classed as immediate, since they followed a reaction developing during the examination. Three fatalities are described as delayed, in that there was no reaction for at least one hour following the injection. These 3 patients died within seventy-two hours, in uremia. The remaining 3 cases are classified as indeterminate because of lack of data surrounding the injection or subsequent course. Two additional deaths following intravenous urography are reviewed from the literature; 1 death is reported from retrograde pyelography.

Of the 3,800,000 examinations on which the report is based, Diodrast was used in 66.6 per cent, Neo-Iopax in 27.2 per cent, and Urokon Sodium in 4.6 per cent. Other contrast media (Skiodan, Hippuran, Ditopax, Iopax, Diodone, etc.) accounted for the remaining 1.6 per cent of the tests. Of the 33 fatalities, 28 followed the use of 35 per cent Diodrast, 3 occurred with Neo-Iopax (1 case 50 per cent, 2 cases 75 per cent), 1 with 30 per cent Urokon Sodium and 1 with a combination of Neo-Iopax and Diodrast. In 6 of the 33 cases, less than the full dose was given, the injection being halted after 2 c.c., 2 c.c., 5 c.c., and 7 c.c. in four instances.

Some kind of a sensitivity test preceding the injection was reported in 56.8 per cent of the returns. "Negative" tests, however, were found not to be reliable. In 15 of the 25 "immediate" deaths, the sensitivity tests had been regarded as negative.

The fatal reactions were ushered in by one or more of the following signs: dyspnea, cyanosis, convulsions, chest pressure, and shock. The causes of death as determined postmortem varied widely. Two patients scheduled for urography died in radiology departments prior to injection of any medium.

Precautionary measures prior to examination included eliciting a careful history, particularly in regard to allergies; sensitivity tests; preliminary medication with barbiturates and/or ephedrine and, more recently, with antihistamines; ready availability of emergency drugs and oxygen. It would seem that prophylactic administration of antihistamines is rising in favor if only because of their sedative action.

Uremia, known iodine sensitivity, and severe allergic histories were the chief contraindications to the use of intravenous contrast media as reported by the answering radiologists.

The authors discuss the pathological physiology of the reactions and the difficulty of appraising any given sensitivity test from an allergic point of view. The presentation of the care of the reactions encountered, including emergency treatment, is detailed.

[No one doing or contemplating intravenous urography should be without the information presented in this article, particularly the prompt handling of the earliest signs of a reaction.—S.S.]

Seventeen tables.

SAUL SCHEFF, M.D.
Boston, Mass.

Clinical Experiences with Hypaque Sodium 50% in Intravenous Urography. Robert M. Lowman, Harrison Shapiro, and Harry R. Newman. *Canad. M.A.J.* 73: 264-269, Aug. 15, 1955.

This report summarizes the results obtained in 400

cases in which Hypaque was used as a contrast medium for intravenous urography. In general, a marked improvement in the diagnostic quality of the urograms, as compared with previous examinations with media of lower iodine concentration, was readily apparent. The results were graded as excellent, good, fair, or poor; visualization equaling that obtained in successful retrograde pyelography was considered excellent. While all categories were represented, results in the majority of cases were rated "good."

It is observed that, despite its "intermediate" iodine concentration, the medium is of low toxicity and is well tolerated by patients. The authors believe, however, that in clinical studies in a larger patient population more reactions would occur. On the basis of the present limited investigations, Hypaque sodium is considered a satisfactory contrast medium and its further clinical trial is considered indicated.

Thirteen roentgenograms; 2 tables.

The Acceleration of Delayed Excretory Urograms with Ingested Ice Water. S. A. Kaufman. *J. Urol.* 74: 243-244, August 1955.

The author calls attention to delayed visualization of the pelvocalyceal system in many patients with ureteral colic and emphasizes the importance in these cases of prolonging the study until the ureter on the affected side is visualized, in an attempt to localize the obstruction. Often a calculus cannot be identified and the impaired renal function may be due in part to spasm. In such cases the simple maneuver of having the patient drink a glass of ice water may afford relief of the spasm and facilitate the examination. An illustrative case is reported.

Two roentgenograms.

WILLIAM T. THORWARTH, M.D.
University of Pennsylvania

Calyceal Cysts of the Kidney. M. Demoullin and L. Nickels. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 83: 208-213, August 1955. (In German)

Calyceal cysts have been reported for the most part in the recent French literature. Their terminology is still not uniform, and the authors prefer to call them diverticula. Four uncomplicated cases are presented and illustrated. Symptoms are either vague or completely absent, and there are no characteristic signs. Although the authors' patients were females, there is no sex predominance.

The diverticula are best seen on retrograde pyelograms as round, well demarcated sacs, either single or multiple, usually in one kidney only. The pedicle leading to an adjacent calyx may be either short or long, narrow or wide. Renal function remains undisturbed in the uncomplicated cases and the kidney contour is regular. The diverticula are coated with normal mucosa and are seen to fill without delay, simultaneously with the calyces, on excretory urograms, in which respect they differ from the slowly filling tuberculous cavities. They must also be differentiated from abscesses and from the parenchymatous cysts of bilateral polycystic disease.

Drainage is apt to be delayed when the pedicle is narrow, and stagnation of contents may give rise to infection and stone formation. Hematuria as a result of ulceration of the mucosa is not rare. When the connecting pedicle closes off, calcified contents will become visible, as so-called parenchymal calculi. Secondary

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Conservative therapy is indicated in the uncomplicated cases.

Six roentgenograms.

ERNEST KRAFT, M.D.
Newington, Conn.

Dilatations of the Ureter: A Casuistic Contribution and Critical Review with Particular Regard to the Problem of Megaureter. Guido Iannaccone and Antonio Marsella. *Radiol. med. (Milan)* 41: 759-775, August 1955. (In Italian)

According to the authors there are three main categories of megaureter: (1) the organic form, which results from obstruction, congenital or acquired; (2) the congenital form of the Hirschsprung type, in which there is malfunction of the bladder due to changes in the ganglionic cells of the pelvic nervous plexus, similar to those encountered in the Hirschsprung type of megacolon; (3) the idiopathic type, of obscure etiology. In the last two types the changes are usually bilateral and the dilatation massive. The congenital form is encountered in children; the idiopathic type may occur at any age.

Three cases are presented. In the first case the failure to find any possible explanation for the massive bilateral dilatation would classify it as idiopathic. The second case presented bilateral stenosis of the ureterovesical junction. The symmetry, absence of any history of acquired disease, and the general appearance suggest a congenital origin. In the third case there was sclerosis of the vesical neck, and an impressive vesicoureteral reflux was observed.

Eleven figures. ALEXANDER R. MARGULIS, M.D.
University of Minnesota

THE ADRENALS

Roentgenographic Visualization of Adrenal Glands: Use of Aortography and/or Retroperitoneal Pneumography to Visualize Adrenal Glands: "Combined Adrenalography." Willard E. Goodwin, E. Vincent Moore, and E. Converse Peirce, II. *J. Urol.* 74: 231-242, August 1955.

The authors emphasize the usefulness of aortography when special preoperative study of the adrenals is needed and advocate a combination of retroperitoneal gas contrast and aortography ("combined adrenalography").

The roentgenographic studies usually employed include excretory urography, survey films of the abdomen (before and after injection of oxygen into the retroperitoneal space), and aortography (either translumbar or by percutaneous femoral catheterization). After opacification of the kidneys and adrenals, roentgenograms are obtained in the postero-anterior, antero-posterior and right and left oblique positions. It is rec-

ommended that the films be centered over the adrenal area and that they be somewhat overexposed. Roentgenograms with the patient erect permit greater visualization of the adrenal space as the kidneys descend. The authors have not employed body-section roentgenography, although they recognize its advantages.

On the basis of several hundred aortograms studied since 1947, it has been observed that the normal adrenal outline on the left is infrequently seen because of the overlying splenic artery. On the right, the hepatic and gastroduodenal arteries obscure the suprarenal spaces. The adrenal arteries are small. The inferior suprarenal (from the renal) is most often demonstrated, followed by the superior adrenal (from the inferior phrenic artery or the aorta). The middle suprarenal is least frequently visualized.

Several case reports are included, illustrating the use of "combined adrenalography" in demonstrating the normal adrenal anatomy, adrenal calcifications, hyperplasia, and medullary and cortical tumors. Two cases of pheochromocytoma are presented. While it was feared that aortography would produce a hypertensive crisis in patients with pheochromocytoma, this was not the experience in these two patients.

Under the heading of "Errors," the authors report a case in which a small tumor was missed on aortography. No retroperitoneal oxygen studies were done in this instance. Early in their experience an abnormal projection of the left lobe of the liver was interpreted as an adrenal tumor, and in a second patient an enlarged tail of the pancreas overlying the left kidney was thought to be a pheochromocytoma.

Eighteen roentgenograms; 1 photograph; 7 drawings.
JOHN H. HARRIS, JR., M.D.
University of Pennsylvania

TECHNIC

Carbonic Acid Gas as a Contrast Medium in the Radiography of Infants and Children. Bernard S. Epstein. *J. Pediat.* 47: 218-221, August 1955.

The average carbonated beverage is said to contain 3.5 c.c. of carbon dioxide gas per cubic centimeter of liquid, under standard conditions. With the ingestion of 100 c.c. of such a beverage, approximately 350 c.c. of carbonic acid gas is liberated in the stomach. In infants and children, in whom a gas distended stomach will overlie the kidneys, this results in much sharper contrast of the pelvocalyceal systems. Such gaseous distention of the stomach can also be helpful in determining whether an opaque foreign body lies inside or outside of the stomach. In adults, gaseous distention of the stomach may be useful in evaluation of the gastric cardia and fundus.

Seven roentgenograms.

H. G. PETERSON, JR., M.D.
New Britain, Conn.

RADIOTHERAPY

Cancer of the Thyroid in Children. Robertson Ward. *Am. J. Surg.* 90: 338-344, August 1955.

Three cases of cancer of the thyroid in children are reported.

The first patient received ten x-ray treatments over a six month period for hyperthyroidism at the age of

nine. With a dosage of 1,000 r calculated at 5 cm. depth, the metabolism dropped from 42 per cent plus to 16 per cent plus. One year after the initial visit multiple nodules were found along both sternomastoid muscles and in the thyroid gland. Resection of the left lobe of the thyroid and dissection of the left cer-

vical lymph nodes was performed, and a pathologic diagnosis of adenocarcinoma of the thyroid was made. Chest films indicated the presence of metastases, but the patient remained in relatively good health. Twelve years later, after the cervical lymph nodes had slowly begun to enlarge, he received x-ray treatment with good response. Three years after this (1947) the tumor was found to absorb radioactive iodine and a dose of 110 mc. was given, followed after two years (1949) by 337.5 mc. All evidence of pulmonary and cervical metastases disappeared. In 1952 biopsy of recurrent neck metastases showed an anaplastic type of growth. These had a poor iodine uptake. The patient died in 1952 at thirty years of age.

There are three interesting aspects to this case: (1) the presence of pulmonary metastases from the age of ten until eighteen without clinical evidence of their existence; (2) the great affinity of the malignant tissue for iodine; (3) the anaplastic nature of the recurrences which took place after the therapeutic use of I^{131} .

The second case was that of a 16-year-old girl operated on for a mass in the left posterior cervical triangle. At operation this was found to be an adenocarcinoma of the thyroid, and right partial lobectomy, left total lobectomy, and left radical neck dissection were performed, with x-ray therapy (2,500 r) post-operatively. Twenty-five years later the patient is without evidence of recurrence.

The third patient was a 4-year-old girl with a palpable mass in the left lobe of the thyroid gland and palpably enlarged lymph nodes. Biopsy showed papillary adenocarcinoma. X-irradiation (200 kv) was given to the neck through four ports for a depth dose of 2,900 r, and thyroid substance was given in tolerance doses. The tumors disappeared and the patient remained well for several years. At fourteen years of age, total thyroidectomy and bilateral neck dissection were performed for recurrent growth. Six years later another nodule was removed, but the patient has since remained well.

These 3 cases are typical examples of childhood carcinoma of the thyroid. They indicate that therapy must be individualized, with the prognosis depending upon several factors, including the pathologic picture, the possibility of complete extirpation, the presence of metastases, the affinity of the tumor for radioactive iodine (I^{131}), and sensitivity to external radiation.

Nineteen illustrations, including 6 roentgenograms.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Nodular Goiters in Children. William J. Norris and William F. Pollock. *Am. J. Surg.* 90: 345-350, August 1955.

Goiters in children are classified as (1) congenital and (2) those appearing later in childhood. About 70 cases of congenital goiter have been seen in North America; 17 of these received some type of surgical treatment.

Congenital goiters can easily be missed. They are almost always soft "cystic" tumors, highly placed, with the upper poles almost in contact with the mandible bilaterally. They extend behind the pharynx and trachea, and anterior displacement of these structures can often be demonstrated in lateral soft-tissue films of the neck.

There are five possible methods of management of congenital goiter.

1. Some clear completely without treatment.
2. Iodine by mouth has been used but failed to reduce the goiter in many cases.
3. The use of thyroid extract to reduce congenital goiters has been partially successful and the consensus is that it is preferable to iodine if medical treatment is to be attempted.
4. X-ray therapy has been used in two cases without benefit. Both were Hürthle-cell tumors, one malignant.
5. The results of thyroidectomy have been uniformly excellent. Every one of the babies so treated was relieved of respiratory obstruction and survived. There is a real hazard of malignant growth even at an early age. Five cases of cancer in a goiter present from birth are cited from the literature.

Reference is also made to a series of 28 children with cancer of the thyroid reported from Memorial Hospital (Duffy and Fitzgerald: *Cancer* 3: 1018, 1950. *Abst. in Radiology* 57: 591, 1951), 9 of whom had received irradiation to the thymus some time before the nineteenth month of life. This suggests that it is potentially dangerous to subject a child to irradiation of the neck for benign disease.

Twenty cases of Hashimoto's thyroiditis have been reported in children. Two were seen by the authors. They refer also to a report from the University of California, in which Hashimoto's thyroiditis was said to have occurred in 39 per cent of hyperthyroid patients after radioactive iodine treatment, compared to only 3 per cent after conventional preparation for surgery (Dailey *et al.*: *J. Clin. Endocrinol. & Metab.* 13: 1513, 1953. *Abst. in Radiology* 63: 622, 1954).

Two tables. FRANK T. MORAN, M.D.
Auburn, N. Y.

Relation of Radiation to Surgery in Cancer of the Breast. Harold W. Jacox. *J.M.A. Georgia* 44: 405-407, August 1955.

The author believes that cancer of the breast is primarily a surgical problem and that the treatment of choice is complete surgical removal of the primary tumor and regional lymph nodes in one block. If intercostal, supraclavicular, or occasionally iliac bone biopsies are positive, the patients are then treated entirely by irradiation. The most important prognostic factor is the clinical extent of the disease at the time the patient first comes for treatment. The histologic type of tumor present in breast tissue is of lesser importance.

In the United States, emphasis has been placed upon eliminating the neoplasm by radical excision of as much potential tumor tissue as possible. In Great Britain, irradiation has been stressed as an adjunct to simple mastectomy with particular attention to intensive roentgen treatment outside the operative field.

The author reviews some of the early results in cancer of the breast and compares them with current results. In summary, he states: "Radiation therapy is a valuable adjunct to radical mastectomy in those patients who have had a microscopically proved infiltrating tumor or axillary metastases. It may be of real benefit when used to supplement simple mastectomy. It is helpful in the inoperable cases of breast cancer and in those with recurrences after mastectomy. Radiation should not be used routinely as a prophylactic measure, but in any case it should be evaluated in relation to the individual situation."

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

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Treatment of Tumors of the Pelvic Cavity with Supervoltage Radiation. J. G. Trump, R. C. Granke, K. A. Wright, W. W. Evans, Hugh F. Hare, Earl E. Ewert, and William L. Conlon. *Am. J. Roentgenol.* 72: 284-291, August 1954.

The authors report their experience with supervoltage (2 MEV) rotation therapy in 25 cases of cancer of the cervix and 20 cases of cancer of the bladder. These were treated at the Massachusetts Institute of Technology and at the Lahey Clinic between 1949 and 1952. An effort was made to include in the treatment field the primary lesion, the surrounding lymphatics, and the tissue extending laterally within the confines of the true pelvis and as high as the sacral promontory. Prior to irradiation the patients were placed in the Trendelenburg position and the small intestine was displaced upward with the aid of a 6-inch Ace bandage. For irradiation the patient was rotated, in the standing position, about a vertical axis while exposed to a horizontal roentgen beam of a circular shape.

The dose distribution within the pelvis was determined by photometric methods with the use of phantoms of anatomical shape. In actual practice the rectum is protected by placing an absorber immediately adjacent to the patient posteriorly. In no case was there evidence of rectal damage unless the patient had received radium treatment several months or years earlier.

The plan was to deliver a tumor dose of 6,000 r in a total of thirty-five treatment days at a rate of 170 r per treatment. Although the results appeared favorable, the elapsed time was insufficient to permit quantitative appraisal of this form of treatment. The response was found to be unfavorable in arteriosclerotic patients and in the presence of uncontrolled infection.

Two roentgenograms; 4 charts; 1 photograph; 2 tables.

ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

Effect of 2 Million Volt Roentgen Therapy on Various Malignant Lesions of the Upper Abdomen. Ruth J. Guttman. *Am. J. Roentgenol.* 74: 204-211, August 1955.

Forty patients with far advanced upper abdominal malignant disease were treated with 2,000,000-volt roentgen rays. Most of the patients had either metastatic carcinomatous involvement of the liver or inoperable carcinoma of the stomach. Treatment was administered through opposing anterior and posterior fields of sufficient size to include the tumor. Calculated tumor doses were 4,000 to 4,500 r delivered over four to five weeks.

Nine of the 40 patients died during or immediately after therapy and are excluded from the analysis. Immediate adverse effects from the treatment were limited and minor. It was not felt that "radiation sickness" was a troublesome problem, and general tolerance to the therapy was good. Later effects are described generally as "very gratifying." Patients survived for periods of two to seventeen or more months. In 75 per cent of them the tumor decreased in size and there was improvement in the general condition lasting from several weeks to a few months. The course in a number of the cases is described in detail.

The author concludes that to assume that radiation sickness will develop consequent to therapy over the liver is not necessarily justified. Improvement in general comfort must be sought, and results are to be

judged in terms of limited palliation. It is felt that these are well worth the effort.

Five roentgenograms; 2 photographs; 1 diagram; 7 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Interstitial Radium Treatment of Cancer of the Cervix Uteri. Clinical Appraisal. James A. Corscaden, S. B. Gusberg, and Walter Kosar. *Am. J. Roentgenol.* 72: 278-282, August 1954.

The authors discuss their experiences with interstitial treatment in a series of 108 cases of cancer of the cervix. In all but 1 patient, there was extension of disease beyond the uterus. Twenty to thirty milligrams of radium are placed in a uterine tandem and a stockade of needles is inserted into the cervix and parametria. The proper direction of the needles is readily determined by a sound within the uterine canal. The principal cause of error from the standpoint of technic was inattention to the spacing of the needles.

Only 2 serious radiation injuries occurred in this series. There was no evidence of needle puncture of the bladder, ureter, or intestine in any instance. There were one case of extrapelvic infection and 4 cases of venipuncture.

In the authors' experience, the clinical results in Stage II and III, following this method, are superior to those attained by the intracavitary technic.

Two tables.
ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

The Advantages and Disadvantages of Irradiation Therapy in Ophthalmology. Moacyr E. Alvaro. *West. J. Surg.* 63: 538-544, August 1955.

The article is a general survey on a very fundamental level of various considerations in the application of radiant energy for therapeutic purposes.

A review of various experimental data summarizing the effects of radiations on ocular tissues is given. A list of eye diseases believed by the author to be benefited by various types of radiotherapy is presented. Mostly he recommends small "anti-inflammatory" doses for various inflammations of the eye and its components.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Irradiation of Lymphoid Hyperplasia of the Nasopharynx. Robert J. Reeves. *Am. J. Roentgenol.* 72: 260-262, August 1954.

The author advocates the use of roentgen therapy rather than radium in the treatment of lymphoid hyperplasia of the nasopharynx. He reviews 1,200 cases, which he classifies in four groups according to symptoms. Because of the ease of application and distribution of radiation, he believes that roentgen therapy is the method of choice, especially in children.

Four to six treatments are required at weekly intervals. A total of 550 r in air is delivered through a 4 X 6-cm. cone, directed toward the mid-pharynx, at 200 kv, with filtration of 0.5 mm. Cu and 1.0 mm. Al.

One photograph; 1 drawing.

ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

A Radium Applicator for Treating Carcinoma of the Nasopharynx. Martin Van Herik and John B. Erich. *Arch. Otolaryng.* 62: 198-201, August 1955.

The authors describe a radium applicator which is

used to supplement x-irradiation in the treatment of squamous-cell carcinoma of the nasopharynx. The applicator is simple in design and inexpensive to construct. It consists of a plaque of Bakelite with rounded edges, measuring $2.0 \times 2.25 \times 0.7$ cm. Three holes are bored in it longitudinally to hold the radium tubes. The tubes are threaded with linen strings that are inserted through the applicator from the bottom and emerge at the top, where the holes are of smaller bore, except that one end of the loop threaded through the center tube is held back so that it emerges from the bottom of the applicator when the tubes have been pulled in place. The tubes are retained in position by tying the strings tightly against the top end of the applicator. The Bakelite wall surrounding each tube is 1.0 mm. thick, and there is 1.5 mm. separation between adjacent tubes. The strength of each radium tube is 50 mg., and the active length is 1.2 cm.; over all, each tube is 1.9 cm. long and 0.4 cm. in diameter. Filtration is with 1.0 mm. of platinum. The strings from the top of the applicator are passed out through one or both nasal cavities and it is drawn through the mouth and up into the nasopharynx, where it is immobilized.

At the time of the report, this device had been used in approximately 30 patients, with no untoward complications.

Four figures.

The Range of Usefulness of Photographic Film in Roentgen Dosimetry. Gerald J. Hine. *Am. J. Roentgenol.* 72: 293-301, August 1954.

The author discusses in some detail the effectiveness and mechanism of roentgen dosimetry with the use of photographic film. This method has the advantage of indicating local variations of radiation intensity while at the same time recording the overall intensity of a larger area.

Film sensitivity varies with radiation energy, so that the film response is not a simple function of radiation dose. The response to low-energy gamma rays, up to 300 kev, depends on the absorption of the radiation within the emulsion, and for this reason photographic film cannot be used for dose measurements with conventional roentgen rays with energies less than 400 kv. For 400 to 2,000 kv, however, film dosimetry gives reliable, accurate results since in this range the emission of high-energy secondary electrons and their interaction with a film emulsion are nearly independent of the radiation energy. For dose measurements with high-energy rays or gamma rays, the film should be surrounded by air-equivalent material of sufficient thickness to secure equilibrium between the primary roentgen rays and the secondary electrons.

Industrial film, such as Eastman Kodak Type A, is suitable for quantitative roentgen or gamma ray work if the film can be exposed to a dose of 1 to 10 roentgens. With other roentgenographic film a complete calibration curve is required for dosimetry purposes.

Seven figures.

ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

Methods of Increasing Accuracy in Radon and Radium Implants. K. W. Mead and K. A. Stevens. *M. J. Australia* 2: 232-235, Aug. 13, 1955.

The authors describe a method for obtaining more accurate single plane radium needle implants by the

use of "Perspex" (Lucite) stabilizers. Each stabilizer consists of two pieces of "Perspex" clamped together by brass screws, and drilled to hold needles in the most favorable geometrical distribution as determined by the radiotherapist. The stabilizer is sutured or taped in place, depending upon the nature and position of the tumor, before the radium needles are implanted. Then, with the stabilizer as a guide, the needles are passed through the previously drilled holes, which act as directors and spacers. Needles of rigid stainless steel have been specially designed by the authors, to prevent bending or bowing at the time of insertion. The ends of the needles have at least 1.5 cm. inactive length to allow for that portion clamped in the stabilizer. Similar stabilizing devices have been constructed for cylindrical volume implants.

The authors also describe a method for obtaining a more exact implantation of radon seeds. The seeds are placed in polyvinyl chloride tubing of suitable diameter to form a "chain." Introduction is performed by a specially designed broad-caliber steel needle, which is passed through the tumor and then withdrawn, pulling into position the chain of seeds. By placing a second guiding needle before the first is withdrawn, the authors believe accuracy in implantation can be much improved over standard methods. Seed chains are particularly useful where rigid needles would be uncomfortable for the patient, as in the tongue or pharynx.

Nine roentgenograms; 5 photographs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Medical Aspects of High Energy Electron Beams.

Lewis L. Haas, Roger A. Harvey, John S. Laughlin, John W. Beattie, and Walter J. Henderson. *Am. J. Roentgenol.* 72: 250-259, August 1954.

The authors report their experiences and results in the treatment of 13 patients with high-energy electron beams. The energy range was from 7 to 22 MEV. Before-and-after illustrations of 8 of these cases show excellent results, though most of them were of the so-called "hopeless" type. Its physical characteristics make this type of therapy most suitable for lesions situated on or near the body surface. Favorable sites of application are the skin, neck, groin, extremities, eyes, parotid glands, maxillary antrum, oral pharynx (including the tonsil), hypopharynx and larynx, and the breast.

The following advantages of the high-energy electron beam over conventional roentgen rays are mentioned: homogeneous dosage in all layers of a lesion; insignificant exit dose beneath the lesion, in healthy tissue; more rapid and better recovery of radiation reactions; low volume dose per tumor dose; less damage to the tumor bed; fewer general symptoms; less bone and cartilage damage. These advantages have been confirmed in clinical application.

There was no significant difference in skin reactions in comparison with radiation from other sources. According to the authors' observations, a tumor dose of 8,600 r is biologically equivalent to about 6,000 r of 400-kv radiation.

Forty-one photographs; 2 charts; 1 table.

ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

June 1956

RADIOISOTOPES

A New Approach to the Treatment of Chronic Leukemia with ^{32}P . E. C. Easson, B. E. Jones, and L. A. Mackenzie. *Brit. J. Radiol.* **28**: 405-409, August 1955.

A series of 48 selected cases of chronic leukemia is analyzed and it is shown that in more than 90 per cent of them there was an exponential relationship between the falling white cell count and the integral body dose from P^{32} . The logarithms of the white cell count plotted against the cumulative integral body dose (most conveniently expressed in millicuries destroyed) give a straight line graph on semi-log paper. This straight line can be extrapolated at an early date in the treatment and permits a prediction of the minimal effective dose for each patient. This method of dose determination has provided satisfactory remissions, both clinically and hematologically.

This exponential relationship was shown to hold in all but 4 of the 48 cases. The minimal effective dose was predicted to within ± 2 mc.

In addition, the authors treated 10 patients with second courses of P^{32} ; 3 have received a third course; and 1 patient a fourth. The pattern of response was noticed to be similar to that following the first treatment, though there was a tendency to increasing sensitivity.

Eight graphs; 1 table. J. R. GISH, M.D.
Henry Ford Hospital, Detroit

A Comparison of the Thyroidal Plasma I^{131} Clearance and the Plasma Protein-Bound I^{131} Tests for the Diagnosis of Hyperthyroidism. Karl R. Paley, Estelle S. Sobel, and Rosalyn S. Yalow. *J. Clin. Endocrinol. & Metab.* **15**: 995-1009, August 1955.

Two tests of thyroid function, thyroidal removal of radioiodide from the plasma and protein-bound I^{131} (PBI^{131}) plasma concentration at forty-eight and ninety-six hours, are compared on the basis of their correlation with each other and with the final clinical diagnosis. The influence of previous thyroid therapy upon the tests is also evaluated, as is the degree of overlap of values obtained in hyperthyroidism and euthyroidism.

Thyroidal plasma iodide clearance is defined as the volume of plasma cleared of iodide per unit time by the thyroid. This is equal to the thyroid uptake divided by the plasma concentration over the same time interval. The thyroid uptake was measured one-half hour after the intravenous administration of 50 to 60 millicuries of I^{131} . The average plasma concentration during this period is that which would result if the average remaining dose were distributed in a space equal to 20 per cent of the body weight. The plasma PBI^{131} concentration is the fraction of the I^{131} dose in protein-bound form per liter of plasma.

One hundred and fifty-one pairs of tests were completed on 136 patients ranging in age from nine to seventy-seven years; 109 had received no therapy to the thyroid other than desiccated thyroid for suspected hypothyroidism; 87 were euthyroid; 18 were hyperthyroid; and in 4 a diagnosis could not be made. The remaining tests were performed on 27 patients who had been treated for thyroid disease other than hypothyroidism.

Whereas good differentiation between toxic and non-toxic states was obtained with both tests in previously

untreated patients, the plasma PBI^{131} test was frequently misleading in patients previously treated for thyroid disease.

The effects of surgical and radioiodine therapy, premedication with desiccated thyroid or antithyroid drugs, and dietary deficiency or excess of iodine on thyroid physiology are discussed.

Six charts; 1 table. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

Interference with Uptake of Radioiodine Tracer During the Administration of Vitamin-Mineral Mixtures. Lawrence A. Kohn and Edna B. Nichols. *New England J. Med.* **253**: 286-287, Aug. 18, 1955.

Occasional discrepantly low radioiodine uptakes are encountered in tracer studies. To test the hypothesis that adjuvant therapy might raise the total daily intake of iodine sufficiently to block uptake of the isotope, the authors administered daily to 8 apparently euthyroid volunteers two capsules of Geval, a popular polyvitamin-mineral preparation, which would give each person 1 mg. of iodine each day. The I^{131} uptake was measured before the test period, after five to nine days of the drug, and in 4 cases fourteen or more days after it was stopped.

The results varied. The uptake was very slightly lowered in 2 subjects and increased in 2. The other 4 showed rather sharp drops, which in 3 instances may be considered as blocks of uptake. One of the 4 had an abrupt fall in uptake associated with marked increase in sense of well-being, and was under study for possible hyperthyroidism. In the 3 subjects showing an apparent block there was a significant return of uptake to the pretreatment level after the drug was stopped.

In view of these observations, it would seem well to question candidates for tracer studies regarding ingestion of compound vitamin-mineral preparations.

One table. ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Nature and Transport of the Iodinated Substances of the Blood of Normal Subjects and of Patients with Thyroid Disease. William S. Dingledine, Rosalind Pitt-Rivers, and John B. Stanbury. *J. Clin. Endocrinol. & Metab.* **15**: 724-731, June 1955.

Twenty-seven patients received I^{131} : 13 with Graves' disease, 4 with toxic nodular goiter, 2 with non-toxic goiter, and 8 with normal thyroid glands. Both electrophoresis and paper chromatography were used to study the sera of these subjects for iodide, thyroxine, and triiodothyronine. The binding properties of these substances to the serum proteins were compared. An attempt was also made to detect abnormal constituents in the sera of hyperthyroid patients.

Electrophoretic studies showed that there is minimal binding of iodide by serum protein. Thyroxine is transported in the serum in conjunction with protein which has electrophoretic mobility between alpha-1 and alpha-2 globulin. A small fraction of serum thyroxine is bound to albumin, but the inter-alpha protein bond is stronger. There are no qualitative differences in the transport of thyroxine between thyrotoxic patients and normal subjects. If thyroxine is made available to the myxedematous patient, it is transported normally. The serum triiodothyronine-protein bond is

less discriminatory than that of thyroxine. Chromatographic studies on the patients failed to reveal the presence of abnormal iodine-containing substances in the sera of hyperthyroid patients. There is, therefore, no evidence of qualitative differences between normal subjects and those with various thyroid disorders, either in the iodinated components of the blood or the mechanisms of transport.

One photograph; 2 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Further Evidence that Hyperthyroidism (Graves' Disease) Is Not Hyperpituitarism: Effects of Triiodothyronine and Sodium Iodide. Sidney C. Werner, Maryloo Spooner, and Howard Hamilton. *J. Clin. Endocrinol. & Metab.* 15: 715-723, June 1955.

In order to eliminate the possibility that inorganic and organic iodine-containing substances might have influenced the findings of a previous study (Werner *et al.*; *J. Clin. Endocrinol. & Metab.* 12: 1561, 1952. *Abst. in Radiology* 61: 861, 1953), which indicated that hyperthyroidism is not the consequence of hyperpituitarism but rather is mediated by mechanisms apart from the anterior pituitary, and to eliminate the chance that doses of thyroid might have been inadequate to suppress a hyperfunctioning pituitary, the effects of *l*-triiodothyronine were studied.

In 26 hyperthyroid patients small and large doses of *l*-triiodothyronine failed to depress the I^{131} uptake significantly. In 12 euthyroid patients with early eye signs only, doses of triiodothyronine ranging from 75 to 500 micrograms caused no depression of I^{131} uptake, while 2 patients who received 1 mg. of the drug showed a slightly depressed uptake. Six patients, in sustained remission from Graves' disease, had a lowered uptake when given small doses of triiodothyronine and in 30 control subjects the uptake was diminished by small doses of the drug. Eight patients who were euthyroid but had eye signs received thyrotropin and demonstrated little increase in I^{131} uptake, but a significant elevation of serum precipitable iodine.

Since iodides cause relief of hyperthyroidism, and since iodine is suspected as an inhibitor of the action of thyrotropin, the effects of small doses of iodides were tested. Nineteen patients with active Graves' disease received sodium iodide in daily doses ranging from 0.7 to 11.2 mg. and showed a diminution of thyroidal uptake of I^{131} . This effect was enhanced only slightly after injection of thyrotropin. The level of serum precipitable iodine was normal after iodide therapy, but it was sharply increased by the thyrotropin.

This evidence indicates that there is no excess of thyrotropin in Graves' disease and that hyperpituitarism is not the causative factor. Derangement of the intrinsic mechanism of the thyroid for trapping iodine could result in Graves' disease. In this disease, iodides do not inhibit the effect of thyrotropin but act directly on the overactive thyroid cell, partially at least by inhibiting the release of thyroid hormone. In Graves' disease, therefore, the normal reciprocal pituitary-thyroid relationship is disrupted. The difference in the response to triiodothyronine between patients with active Graves' disease and those with other related conditions may provide a useful diagnostic test.

One photograph; 3 tables.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

The Use of Radioactive-Labeled Protein and Fat in the Evaluation of Pancreatic Disorders. William W. Shingleton, Marius H. Wells, George J. Baylin, Julian M. Ruffin, and Aaron Saunders. *Surgery* 38: 134-142, July 1955.

In an effort to fill the need for a simple, accurate index of function in chronic diseases of the pancreas, a test based upon the ability of subjects to digest and absorb radioactive-labeled protein or fat has been developed. Gelatin tagged with I^{131} -labeled serum albumin was used as a protein test meal and an emulsion of peanut oil tagged with I^{131} -labeled glycerol trioleate was used for the fat digestion and absorption test. Thyroid uptake was first blocked by oral iodide ingestion. Periodic blood samples were taken for radioisotope analyses at hourly intervals following the test meals.

After control tests were performed on one group of dogs, another group was subjected to total pancreatectomy. These animals were then tested with the I^{131} -labeled protein and fat meals. A marked decrease in the blood radioisotope content was apparent in all animals following pancreatectomy with either the labeled protein or fat meals. This change was more pronounced, however, when fat was the test material.

A similar control series was run on healthy human volunteers, the blood radioisotope contents being determined after test meals of I^{131} -labeled protein or fat. Fifteen patients with proved pancreatic disease were studied in a similar fashion. Ten patients were tested with I^{131} -labeled protein, 9 with radioactive-labeled fat, and 4 with protein and fat. All but 1 of the 10 protein-tested patients showed blood levels of I^{131} lower than those found in the normal group. The radioisotope concentration in the blood varied inversely with the severity of the disease. When fat was used as the test material, all 9 of the patients with pancreatic disease showed distinctly low blood isotope levels. Two of these patients had pancreatic carcinoma and each showed a similar low isotope content. The 1 patient whose blood level was normal after the protein test meal was re-examined four months later with the fat test meal and was found to have a low isotope level.

These tests are based upon the concept that protein and fat digestion and absorption are proportionate to pancreatic enzymatic activity. Fat digestion appears to be more critically affected by pancreatic insufficiency. If the test is employed as a clinical measure, the test meal should be combined with x-ray barium studies to evaluate gastric emptying time, for the digestion and absorption and resulting radioiodine blood levels vary according to the evacuation rate of the material from the stomach. It is suggested that urine analysis for radioactivity may be a valuable adjunct to this test but further evaluation on this point is required. Fecal analysis for the I^{131} content may be the preferred test for cystic pancreatic fibrosis, since the residue would represent the undigested and unabsorbed portion of the fat meal.

Charts are included in this report showing the isotope blood levels in the experimental studies as well as in the clinical studies, with comparative curves for the controls. These charts are given for both the fat and protein test meals and offer an index for the anticipated normal concentration values as well as the deviations shown in the abnormal subjects.

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observations in the respective groups, it is reasoned that the test meals (particularly radioactive-labeled fat) offer a critical and valid diagnostic index of chronic pancreatic disease.

Seven figures.

JOHN W. WILSON, M.D.
University of Texas, Dallas

The Accumulation of Radioactive Iodine by Human Fetal Thyroids. Robert E. Hodges, Titus C. Evans, James T. Bradbury, and William C. Keettel. *J. Clin. Endocrinol. & Metab.* 15: 661-667, June 1955.

In an effort to establish the limits of safety for the use of radioactive iodine in the thyrotoxic pregnant female, fetuses from 9 therapeutic abortions were studied. The fetuses, ranging in age from six and a half to fifteen weeks, were taken approximately twenty-four hours after the administration of 500 microcuries of I^{131} to the mothers. The maternal uptake of I^{131} was determined, and the radioactivity of the fetal thyroids was measured qualitatively by counting, microscopy, and radioautography. The studies indicate that the human fetal thyroid accumulates I^{131} as early as the twelfth week of gestation. It was not determined whether the fetal accumulation was sufficient to produce damage to the fetal thyroid gland.

Six radioautographs; 6 photomicrographs; 1 table.

RICHARD F. McCLURE, M.D.
Redondo Beach, Calif.

Thyroid Function Studies on Children Receiving Cobalt Therapy. Charles H. Jaimet and Henry G. Thode. *J.A.M.A.* 158: 1353-1355, Aug. 13, 1955.

The authors found no significant change in thyroid function in 17 children fed up to 6 mg. of cobaltous chloride (in an iron-cobalt preparation) per kilogram of body weight daily for ten weeks. Thyroid function studies included radioactive-iodine uptake, conversion ratio, and saliva protein-bound-iodine activity determinations. The authors conclude that in the doses given for the stated length of time the cobalt-iron preparation used does not affect thyroid function nor is it goitrogenic.

[These observations are in contrast to those reported earlier by Kriss, Carnes, and Gross (*J.A.M.A.* 157: 117, 1955. *Abst. in Radiology* 65: 829, 1955), and the latter authors defend their position in the correspondence columns of a subsequent issue of the *J.A.M.A.* (159: 708, 1955).]

SAUL SCHEFF, M.D.
Boston, Mass.

Evaluation of Peripheral Circulation with Radioactive Iodinated Serum Albumin. A Preliminary Report. Joseph M. Levenson, Louis E. Jimenez, Eli T. Samet, and Morris T. Friedell. *Arch. Surg.* 71: 167-170, August 1955.

Radioactive materials have been used in the study of peripheral circulation since 1927. The earlier methods depend on the blood flow and diffusion of the isotope in and out of the vascular bed. In 1952 it was verified that serum albumin tagged with I^{131} remains primarily within the vascular bed for long periods of time and that it is a satisfactory substance for studies of peripheral circulation when used intravenously.

In this investigation the apparatus used consisted of a scintillation counter, a count rate computer, and a graphic recorder. All studies were carried out on the lower extremity with the subject lying comfortably on

the examining table in a quiet room free from drafts, with a relatively constant temperature. With the sole of the extremity examined resting lightly in direct contact with the scintillation counter, 100 to 130 microcuries of radioactive iodinated albumin was injected rapidly into an antecubital vein.

In 10 clinically normal lower extremities the peak of radioactivity was reached in approximately four minutes. There was an almost immediate response to lumbar sympathetic block in the normal extremity, directly indicating vasodilation by a rise in radioactivity. In the extremity with deficient arterial circulation, the radioactivity was less than normal. There was, however, a definite rise in the number of counts per minute in such extremities after a sympathetic block, the number of counts to reach a plateau being roughly doubled. The effect of surgical gangliectomy was found to parallel the effect of a sympathetic block.

Three graphs.

CLAUDE D. BAKER, M.D.
University of Louisville

Systemic Absorption and Urinary Excretion of RISA from Subarachnoid Space. Shelley N. Chou and Lyle A. French. *Neurology* 5: 555-557, August 1955.

This is a preliminary report of an investigation of systemic absorption and clearance of radioactive iodinated human serum albumin (RISA) injected intrathecally in the lumbar region and of the rate of diffusion of RISA in the cerebrospinal fluid along the neural axis.

Eight patients were studied, determinations of radioactivity being made at selected points along the spinal column. After intrathecal injection of the tracer material (approximately 100 microcuries of RISA diluted in 2 c.c. of normal saline solution), diffusion takes place immediately both cephalad and caudad. Neither the cisterna magna or the parietal area shows a significant accumulation of activity during the first hour. The cisterna activity then increases, and at the end of the second hour the parietal activity level also begins to rise. The rate of increase in the cisterna magna and the parietal area exceeds that of the upper thoracic region, probably due to the greater cerebrospinal fluid volume in the former. After the eighth hour, activity levels over each point change very slowly, but equilibrium is not established until almost the twentieth hour following injection. At approximately twenty-four hours the activity in the thigh reaches its peak and then decreases gradually, paralleling the decrease of all the areas.

The peak of activity in the blood following intrathecal injection of RISA is reached in about forty hours. From then on, there is a gradual disappearance of RISA from the blood stream. It can be assumed from this study that the exchange of RISA between cerebrospinal fluid and the blood is in equilibrium at about forty hours following intrathecal administration. This is in contrast to equilibrium at twenty to twenty-four hours when RISA is injected intravenously.

The peak of urinary excretion of RISA occurs on the second day after injection.

It appears that the optimum interval for isotope ventriculographic study is approximately twenty-four hours after intrathecal injection of RISA. This is when the cerebrospinal fluid activity is highest as compared to a rising blood activity.

Four illustrations.

RADIATION EFFECTS

Radiation Dangers in Diagnostic Radiology. Israel E. Kirsh. *J.A.M.A.* 158: 1420-1423, Aug. 20, 1955.

The U. S. Public Health Service estimates that there are 126,000 x-ray units for diagnosis and therapy in this country—50,000 used by physicians and hospitals, 65,000 by dentists, and 11,000 by osteopaths and chiropractors. In addition, there are 2,000 radiographic units in industry and some 30,000 sales people use fluoroscopes in shoe fitting. Radium can be bought in the open market by individuals unacquainted with its dangers. Radioisotopes are being distributed more extensively. We are all also exposed to an unavoidable source—cosmic radiation—which has been estimated as totaling up to 9 r in a lifetime of seventy years.

The author's main concern is gonadal injury and he stresses the harm that may result from small doses of radiation, delivered in the course of fluoroscopy and diagnostic radiography. He carried out measurements with diagnostic units for examinations which are most likely to affect the gonadal area, namely, studies of the lumbosacral spine and of the urinary tract. Additional aluminum filtration was found to reduce considerably the roentgen output per minute. At the present time the fluoroscopy units in his department have a 3 mm. aluminum filtration, which on one machine has cut the output from 12 r per minute (without filtration) to 2.8 r per minute. Addition of 2 mm. aluminum filtration to radiographic machines reduced the dose of radiation by 80 per cent at 50 kv and by 70 per cent at 100 kv. This additional aluminum filtration does not have any effect upon the technical factors of radiography.

The fluoroscope should not be set higher than 3 ma., as higher currents add nothing except radiation. The use of automatic timers on fluoroscopes and restriction of the fluoroscopic beam would also serve to decrease radiation dose.

Another possible approach to the problem of protecting the gonads in radiographic examination is to place a protective lead covering over them. This is feasible in the male, but in the female it would probably obscure the site being examined.

The geneticist's concept of "maximum permissible exposure" should alert us to the long-range danger for individuals and the population as a whole from relatively small doses of radiation resulting from fluoroscopy and radiography.

Four tables. JOHN P. FOTOPoulos, M.D.
Hartford, Conn.

Autoradiographic and Histopathological Studies of Thorium Dioxide Patients. The Deposition of Thorium and Its Daughter Radioelements in the Soft Tissues and Skeleton Following Thorium Dioxide Administration. W. B. Looney, J. S. Arnold, H. Levi, and W. S. Jee. *Arch. Path.* 60: 173-178, August 1955.

A number of reports on the late clinical changes following the internal deposition of radioactive materials have been published by the author and his associates (see, for example, *Arch. Path.* 56: 1, 1953. *Abst. in Radiology* 62: 797, 1954; *Ann. Int. Med.* 42: 378, 1955. *Abst. in Radiology* 65: 967, 1955). The present paper describes the autoradiographic and histopathologic findings in 2 patients who died ten and nineteen years after thorium dioxide administration.

Problems relating to the calculation of the amount of irradiation received by the body and the various organs are discussed.

One photograph; 11 autoradiographs and photomicrographs, 4 in color.

Determination of the Radioactivity of Gallstones Obtained from Cases of Gallbladder Cancer. Joseph G. Fortner and William P. Norris. *Cancer* 8: 687-688, July-August 1955.

The association of gallbladder carcinoma and gallstones has long been recognized. As early as 1912, Lazarus-Barlow reported on the radium content of gallstones from 6 cases of carcinoma of the gallbladder. Gallstones obtained from patients without neoplastic gallbladder disease were shown to contain no radium. The obvious conclusion was that the carcinoma was a direct result of radiation from the gallstones.

To confirm the findings of Lazarus-Barlow, the present authors obtained gallstones from 6 patients with proved carcinoma of the gallbladder and measured the radium content by a thallium-activated sodium iodide-crystal scintillation counter, a Lindemann-Ryerson electrometer with dual balanced ionization chambers, and by coprecipitation of radium with barium chloride and counting with an alpha counter. Gallstones from benign gallbladders were also analyzed. In no instance was a reading obtained that was significantly higher than background.

JOHN W. WILSON, M.D.
University of Texas, Dallas

Some Effects of Radiation on Lymphoid Cells: Part II. D. O. Shiels. *M. J. Australia* 2: 239-242, Aug. 13, 1955.

In a previous paper (*M. J. Australia* 2: 583, 1954. *Abst. in Radiology* 65: 320, 1955) the author has shown that the ratio of monocytes plus large lymphocytes to small lymphocytes, and the percentage of lymphocytes which have granules in the cytoplasm as studied on stained blood smears, are both significantly different in persons who have been exposed to small amounts of ionizing radiation than in normal unexposed controls. Further studies have been conducted on 6 individuals exposed to small amounts of ionizing radiations over a period of months. Three of the studied individuals had been exposed to small but unknown amounts of radiation for some years but had been away from such exposure for several months prior to the commencement of these tests. The other 3 were younger persons who had had no history of radiation exposure prior to the commencement of the test period.

It is shown that, in individuals exposed to ionizing radiations of small intensity for several months, the following changes are demonstrable: an increased ratio of monocytes plus large lymphocytes to small lymphocytes, an increased ratio of large to small lymphocytes, an increased percentage of lymphocytes with granules in the cytoplasm, and an increased percentage of abnormal-appearing monocytes in the stained blood smear. Individuals who had had exposure in past years showed more marked increases in these values than younger persons exposed for the first time. None of the ratios were increased for a series of 7 control subjects who had had no known radiation exposures.

Five tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Effect of Hypophysectomy and X Irradiation on Lymphoid Organs and on the Induction of Lymphoid Tumors in C57BL Mice. C. Susan Nagareda and Henry S. Kaplan. *J. Nat. Cancer Inst.* 16: 139-152, August 1955.

Few reports on the effects of hypophysectomy on tumorigenesis have appeared in the literature. Since the pituitary is essential for growth in general, it has been suggested that the hormones produced by this gland may play an important role in neoplasia as well. The authors report experiments on mice in which hypophysectomy had been carried out twenty-eight days earlier, when the animals were thirty to forty days old. X-ray treatment was given in four whole-body exposures of 119 r each at eight-day intervals. Thymus weights of hypophysectomized male mice significantly exceeded those of intact controls of the same age. In the females there was no difference in relative thymic weight. Relative lymph node weights of both sexes were significantly higher in the hypophysectomized mice than in the control mice. Relative spleen weights were almost the same in hypophysectomized and control male mice, but in females there was a definite decrease following operation. The radiosensitivity of lymphoid tissues appeared to be moderately increased by hypophysectomy. Experiments and observations showed that post-irradiation recovery of the lymphoid tissue was slower in the hypophysectomized animals.

Another experiment revealed that shielding of the thigh during total-body irradiation of hypophysectomized mice accelerated lymphoid tissue recovery. Various tests have shown that the absence of the pituitary does not inhibit the development of radiation-induced lymphoid tumors in strain C57BL mice. After the first x-ray exposure, with a mean latent period of 160 and 180 days, approximately 60 per cent of the mice in hypophysectomized and intact irradiated groups were found to have lymphomas. Leukemogenesis was just as effectively inhibited in hypophysectomized as in intact mice by thigh shielding during exposure.

Many authors have reported that hypophysectomy effectively inhibits the tumorigenic action of certain carcinogenic agents and the pituitary-adrenal axis may be involved in the carcinogenic action of azo dyes. In this respect, it appears that the mechanism for the induction of sarcomas and liver tumors by carcinogens in rats differs from that of lymphoid-tumor induction by x-ray irradiation in mice. In any case, the authors' observations refute the possibility that the pituitary plays a universally essential role in carcinogenesis. Hypophysectomy will significantly modify tumor genesis only in those tissues toward which the pituitary exhibits distinct growth-conditioning activity.

Nine graphs; 5 tables. SAIM GOKHAN, M.D.
Mercy Hospital, Pittsburgh

Functional Studies of the Hyperplastic Spleen of Mice Recovering from Radiation Damage. Willie W. Smith, Ilo M. Alderman, and H. Jeanette Ruth. *Am. J. Physiol.* 182: 403-406, August 1955.

Three experiments were carried out by the authors, in an investigation of the hematopoietic properties of the hyperplastic spleens of mice recovering from radiation damage. The first was a study of the differential leukocyte count and resistance to experimental infection in intact and splenectomized mice; the second, of leukocyte mobilization following *Pseudomonas* infec-

tion in sublethally irradiated mice; the third, of the effect of homogenate of hyperplastic spleens on survival of lethally irradiated recipients.

Granulocyte counts were found to be substantially higher in intact than in splenectomized mice twenty days, but not fifteen days, after exposure to 600 r. Intact mice had a higher resistance than splenectomized mice to *Pseudomonas* challenge both fifteen and twenty days after exposure to 600 r. This difference was greater than could be attributed to differences in pre-infection granulocyte count and, allowing for granulocyte differences, it was essentially the same fifteen days (spleen weight 64 mg.) as twenty days (spleen weight 149 mg.) after irradiation. Mice exposed to 475 r failed to mobilize granulocytes in response to a *Pseudomonas* infection twelve days after irradiation, but showed an increasing degree of mobilization at fourteen and sixteen days. The beneficial effect of homogenate of hyperplastic recovering spleens on lethally irradiated recipients was the same as that of homogenate of spleens from normal two-week-old mice.

Two graphs; 3 tables.

Effect of Parenteral Injections of Particulate Matter on Survival of X-Irradiated Animals. Falconer Smith, Willie W. Smith, Howard L. Andrews, and Marie M. Grenan. *Am. J. Physiol.* 182: 396-399, August 1955.

Experiments are described which show that the post-irradiation parenteral injection of suspensions of inorganic particulate matter, including limestone, quartz and Pyrex glass, increases the survival of mid-lethally irradiated mice by about 22 animals per hundred. Comparable increases in survival were observed in irradiated guinea-pigs and hamsters but were not seen in rats given glass particles. Particulate matter could be varied in size from <44 to 74μ and in amount from 5 to 50 mg. without loss of effect on survival in irradiated mice.

The protective action of the particulate matter is probably associated with an inflammatory response in the animal induced by the presence of the relatively insoluble particles, enhancing the defenses against the infection which follows mid-lethal irradiation.

Two graphs; 3 tables.

Effect of Parenteral Injection of Particulate Matter on Resistance of X-Irradiated Mice to Infection. Willie W. Smith, Falconer Smith, and Ilo M. Alderman. *Am. J. Physiol.* 182: 400-402, August 1955.

A parenteral injection of particulate matter following mid-lethal irradiation was found to increase survival in irradiated mice (see preceding abstract). Experiments described in the present paper support the view that this increase in survival is largely due to a reduction in the incidence of *Proteus* and *E. coli* infection, while the incidence of *Pseudomonas*, which invades and kills earlier, was not diminished.

In mice injected with particulate matter following sublethal irradiation, resistance to *Proteus* or *Pseudomonas* challenge was increased five to twelve days after irradiation, although granulocyte counts in tail blood were no higher than in parallel groups not injected with particulate matter. Both intraperitoneal and subcutaneous injections of particulate matter were effective against intraperitoneal, subcutaneous, or intravenous challenge. The injection of glass particles increased survival to almost the same extent in mice

immunized prior to irradiation and subsequently challenged with a twofold concentration of *Proteus* culture as in mice not immunized and challenged with a 1:10 dilution of the culture.

One graph; 3 tables.

Mitochondrial Changes in Hepatic Cells of X-Irradiated Mice. Ross C. MacCardle and Charles C. Congdon. *Am. J. Path.* 31: 725-745, July-August 1955.

This paper deals with the effect of total-body roentgen irradiation upon the mitochondria of hepatic cells in mice. Two hundred and forty-nine mice were irradiated in groups exposed to 500 r, 900 r and 1,200 r, respectively. One hundred and forty-seven unirradiated mice served as controls. In some instances, the mice were deprived of food for twenty-four hours prior to x-irradiation and until the time the liver was excised.

The mitochondria of the mouse liver are normally found in the form of filaments, globules, and rods. The filamentous and rod-shaped mitochondria are polarized perpendicular to the blood-vascular surface of the cell, and the free ends of the mitochondria are directed toward the nuclear membrane. The cellular mitochondria differ according to the zone of the liver lobule in which they reside. Filamentous forms predominate in the central portion (near the central vein), thicker filaments in the mid-zone, and short rods in the peripheral cells (near the portal vein).

Twenty-two fed mice were exposed to 500 r and the liver was excised and fixed six to eight hours after the irradiation. Only 10 of these mice showed alterations in the distribution and form of mitochondria. In the mid-zone of the liver lobule many of the mitochondria appeared vesiculated and aligned against the vascular surface of the liver cell. Peripherally the mitochondrial filaments and rods appeared more densely packed. There was no indication whether new mitochondria were being formed by the cytoplasm or from substances absorbed from the blood stream.

Of 42 fed animals exposed to 900 r total-body radiation and examined six to eight hours later, 38 showed vesiculation, fragmentation, and globulation of the mitochondria in the mid-zonal and peripheral cells of the lobule. Grossly the mice appeared normal at this interval. At twenty-four hours, the mitochondria were fragmented and there was wide-spread globulation, and the animals were quiet in the cage. At forty-eight and ninety-six hours, when the animals appeared moribund, there were not only globulation and fragmentation but marked diminution in the mass of the mitochondria.

All of the 35 fed mice exposed to 1,200 r revealed mitochondrial changes. Those examined six to eight hours after irradiation showed globulation of the mitochondria in the peripheral portal zone and mid-zone, with the changes occurring principally in the peripheral cytoplasm against the vascular surface of the cell. In most of the mice of this group examined at forty-eight hours the mitochondria were diminished in number, with later changes indicating cellular degeneration. It was noted that there was a distinct increase in intranuclear bodies (nucleoli?).

A group of mice exposed to the varying doses of x-radiation were given intravenous injections of bone marrow (obtained from normal mice), which apparently protected them against the effects of the radiation, since they appeared more active and more normal grossly. Following 1,200 r irradiation the hepatic cells in the

injected mice were rich in mitochondrial elements, particularly in the peripheral portal region, which assumed the form of short rods. None of the mice exposed to this amount of radiation, however, showed a completely normal state of mitochondria. Injected mice irradiated at 900 r seemed to recapture a normal state of the mitochondria of the liver cells.

It is believed that the alterations of the mitochondria represent radiation injury, but on the basis of previous studies it is conceded that these effects are not peculiar to x-irradiation. Other factors, such as heat, induce similar changes.

Twelve illustrations; 2 tables.

JOHN W. WILSON, M.D.
University of Texas, Dallas

Recovery from Acute Radiation Injury in Mice Following Administration of Rat Bone Marrow. Leonard J. Cole, John G. Habermeyer, and Victor P. Bond. *J. Nat. Cancer Inst.* 16: 1-9, August 1955.

This study of the post-irradiation protection of mice exposed to lethal radiation by rat bone marrow is an extension of a previous study by Congdon and Lorenz (*Am. J. Physiol.* 176: 297, 1954. *Abst. in Radiology* 63: 918, 1954). A similar dose of radiation was used, but the animals were kept under observation longer and some also received cortisone. The authors confirm the observation that the heterologous marrow protects the animals as late as sixty days after irradiation and that, in contrast to homologous bone marrow protection, there is a large percentage of late deaths. It is suggested that a delayed immunologic response to the foreign marrow may account for this. Cortisone appears to increase the protective action to some extent.

Two graphs; 3 tables. J. C. EVANS, M.D.
Mercy Hospital, Pittsburgh

The Response of Hypophysectomized Rats to X-Radiation and Replacement Therapy. E. A. Sellers and John C. Barlow. *Radiation Res.* 2: 534-537, August 1955.

This paper reports a study of the relative importance of some of the individual hormones of the anterior pituitary on resistance to radiation and of the effects of certain hormones whose activity or production is affected by the anterior pituitary.

Hypophysectomy was found to reduce the resistance of rats to x-irradiation (400 or 600 r of whole-body irradiation). Of the various materials given to hypophysectomized rats after irradiation (ACTH, growth hormone, insulin, thyroxine, cortisone, testosterone), only thyroxine increased the percentage survival. Hypophysectomized irradiated animals given insulin died sooner than the hypophysectomized irradiated controls.

One table.

Role of Hypotension in the Initial Response of X-Irradiated Chicks. S. P. Stearns, A. M. Brues, M. Sanderson, and E. J. Christian. *Am. J. Physiol.* 182: 407-410, August 1955.

The early mortality that follows total-body exposure of young chicks to doses of ionizing radiations above LD 50/30 is dose-rate dependent. Although progressive renal failure has been shown to precede death in the early period after irradiation, results of partial-body exposures have established that renal failure may also occur without direct exposure of the kidneys, indicat-

ing that indirect effects play a role in the renal dysfunction. The syndrome associated with the initial reaction suggests that a generalized circulatory collapse may be involved. The present report is concerned with the hypotensive response in the initial period after irradiation and its relation, in both partially and total-body irradiated chicks, to early renal failure.

In young chicks, a severe hypotension developed during the initial period following exposure to 1,000 r x-rays (43 r/min.). Birds that failed to survive the first twenty-four hours showed a small drop in blood pressure soon after exposure and a more drastic fall during the last half of the survival period. The early hypotension was not associated with any significant renal dysfunction, but complete anuria was seen as more severe hypotension developed. Shielding the kidney region during irradiation prevented direct damage to the kidneys, but did not prevent either severe hypotension or renal failure. On the other hand, local irradiation of the kidney region had no effect on the blood pressure, but frequently caused sufficient direct renal injury to result in a fatal uricemia. Effects of sustained hypotension produced by controlled hemorrhage indicate that the low arterial pressure during the last half of the post-irradiation survival period was insufficient to maintain normal renal function.

Four figures.

The Effects of Dose Rate Variation of Fission Neutrons and of Co^{60} γ -Rays on Survival in Young Chicks. Howard H. Vogel, Jr., and S. Phyllis Stearner. *Radiation Res.* 2: 513-522, August 1955.

The authors describe a study of the survival of young chicks exposed to fast neutrons and to γ -rays at different dose rates and of the relative biological effectiveness (RBE) of these two ionizing radiations in causing lethality in the chick.

Three-day-old white leghorn chicks were irradiated with fast neutrons at dose rates of 1 rep/min. and 4 rep/min. Twenty-one-day mortality curves were constructed for each dose rate. The survival of the chicks exposed at the lower dose rate was markedly higher than for those exposed at the higher rate, the 21-day LD 50 being 306.5 ± 4.1 rep and 236.0 ± 3.9 rep, respectively. Also, the slope of the mortality curve at the lower intensity was less than that of the 4-rep/min. exposures.

Similar survival curves were constructed for chicks exposed to Co^{60} γ -rays at 6 r/min., 12 r/min., and 22 r/min. Combined data for the two higher dose rates (which were not significantly different) showed a 21-day LD 50 of 878.4 ± 19.4 r. When the low dose rate of 6 r/min was used, this figure was increased to 1207.4 ± 21.9 r.

After exposure to the higher dose rates of both these ionizing radiations, an early mortality was evident during the first two days after irradiation. This response was similar to that seen after x-ray exposures at dose rates of 15 r/min. or higher. Autopsy examinations indicated a high incidence of visceral hemorrhages. This early mortality and the correlated pathological findings were not commonly observed after low-dose rates of x-rays, γ -rays, or fast neutrons.

The relative biological effectiveness of fast neutrons and Co^{60} γ -rays for producing 21-day lethality in the chick was found to be 3.72 when the high-dose rate survival curves were compared.

Three figures.

Susceptibility to Thrombosis in Normal Young, Aging, Cortisone-Treated, Heparinized and X-Irradiated Hamsters as Tested by Topical Application of Thrombin. Herbert J. Berman, George P. Fulton, Brenton R. Lutz, and David L. Pierce. *Blood* 10: 831-840, August 1955.

Thrombin applied topically to the everted cheek pouch of the hamster produces platelet thromboembolism, varying in degree according to the condition of the animal. The authors describe such *in vivo* tests for measuring susceptibility to platelet thrombosis.

Results of their experiments showed that thrombin applied topically produced platelet and not red thrombi in exposed, uninjured blood vessels with circulating blood. Red thrombi were produced in stagnant blood. Thrombus formation occurred in the venules for the most part and seldom in arterioles or capillaries. Thrombus susceptibility was found to increase with age and during cortisone treatment and to decrease after heparin injection and following large doses of whole body x-irradiation.

No significant change occurred in thrombus susceptibility (as compared with the controls) during the first four to five days following irradiation. The decreased susceptibility was demonstrated at six to eleven days, and a correlation was found with the platelet count. With a thrombocytopenia of 50,000 platelets per cubic millimeter or lower, platelet thrombi were not produced by thrombin solutions, even by those of 100 per cent concentration. The blood usually continued to circulate, but red thrombi formed eventually. With platelet concentrations of 100,000/cu.mm. or more, the susceptibility of platelet thrombosis remained within the range established for the control hamsters.

Four photomicrographs; 7 graphs.

FRANK T. MORAN, M.D.
Auburn, N. Y.

Radiation Studies on the Monkey Eye. I. Effects of Gamma Radiation on the Retina. David V. L. Brown, Paul A. Cibis, and John E. Pickering. *Arch. Ophth.* 54: 249-256, August 1955.

Co^{60} gamma radiation of 10,000 r was delivered at a rate of $1,000 \pm 50$ r/min. to the head (body shielded) of 16 monkeys, to the body (head shielded) of a second group of 16 monkeys, and to the whole body (including head) of a third group of equal size. Five other monkeys served as controls. The animals were killed by decapitation at intervals of 2, 4, 8, 12, 24, 48, 72, and 96 hours following irradiation.

Animals in the second group, those receiving radiation to the body only, showed no ocular reaction except for the presence of a very small number of cells visible in the anterior chamber at each examination. These either had disappeared completely or were seen to be adherent to the anterior lens capsule in animals surviving up to ninety-six hours.

Changes seen in the eyes of animals whose heads were irradiated were essentially similar to those seen in the animals receiving whole-body irradiation. Clinical manifestations consisted of severe iridocyclitis, retinal edema, papilledema, severe hypotony, and, in a few cases, punctate and flame-shaped retinal hemorrhages. Histological abnormalities consisted chiefly of pyknosis of the rod nuclei (apparent as early as two hours following irradiation) and degenerative sequelae in the outer nuclear and bacillary layers. Both clinical and histologic changes developed in a definite time pattern.

Eleven photomicrographs; 1 table.

Comparison of Cytologic Effects Produced by 220 kV_p Roentgen Rays, Radio-Iridium Ir¹⁹² Gamma Rays and 30 MeV_p Roentgen Rays in the Microspores of *Tradescantia bracteata*. K. C. Bora. *Acta radiol.* **44**: 129-144, August 1955.

For more complete information on the relative biological efficiency of higher energy roentgen rays, filtered and pulsed 30-MEV_p roentgen rays from a synchrotron were compared with 220-kvp roentgen rays from a Maximar therapy machine and gamma rays of a mean energy 0.4 MEV produced by radio-iridium, Ir¹⁹². In 1953 a preliminary report of this study was published by Mitchell, Smith, Allen-Williams, and Braams (*Acta radiol.* **40**: 603, 1953. *Abst. in Radiology* **63**: 622, 1954).

In the present study cytologic changes in the microspores of *Tradescantia bracteata* were determined as biologic criteria.

In equivalent doses, 220-kv roentgen rays produced more chromatid and chromosome aberrations than 0.4-MEV gamma rays from Ir¹⁹² or 30-MEV roentgen rays from the synchrotron. The radiation from 0.4-MEV gamma rays and 30-MEV roentgen rays did not produce significant quantitative or qualitative differences in chromosomal injury. It was found that equal doses of 30-MEV roentgen rays and 0.4-MEV gamma rays produce like frequencies of chromosomal changes at low dosage levels (100-500 r), but with higher doses (600-1,000 r) "the same dose of the former

radiation produces lower frequencies of all types of aberration."

Four diagrams; 2 photographs; 6 tables.

SUE L. NICKEY, M.D.
University of Texas, Dallas

Certain Effects of Irradiation and Chemotherapy on Cellular Division and Differentiation. Nathan B. Friedman, James A. Sargent, and Eileen Drutz. *Cancer Res.* **15**: 479-484, August 1955.

Analysis of the reactions produced in tissues of rats by irradiation or the administration of chemotherapeutic agents reveals that such factors do more than interfere with cellular division. Some modalities inhibit the completion of mitosis in cells with the capacity of multiplication, some interfere with premitotic nuclear metabolism, and others inhibit an earlier cytoplasmic phase of synthesis. A comparable interference with cytoplasmic synthesis and an inhibition of differentiation are exercised by some of the drugs on the somatic cells which lack the ability to divide, while irradiation in therapeutic doses and other chemical agents do not interfere with differentiation. Although tumors in general are presumed to arise from reserve cells, spontaneous differentiation occurs not uncommonly. The possibility of enhancement of the tendency to differentiate is a relatively neglected but important effect of irradiation and selective chemotherapy.

Six photomicrographs; 9 charts.



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